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Miller et al.

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(54) **TRAILER WITH REAR IMPACT GUARD**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 28 days.

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(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 15/240,237, filed on Aug. 18, 2016, now Pat. No. 9,771,040.
(Continued)

(51) **Int. Cl.**
B60R 19/24 (2006.01)
B60R 19/56 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***B60R 19/24*** (2013.01); ***B60R 19/56*** (2013.01); ***B62D 25/08*** (2013.01); *B62D 33/04* (2013.01); *B62D 53/06* (2013.01)

(58) **Field of Classification Search**
CPC ... B60R 19/24; B60R 19/56; B60R 2019/247; B60R 2021/002; B62D 33/04; B62D 53/06
(Continued)

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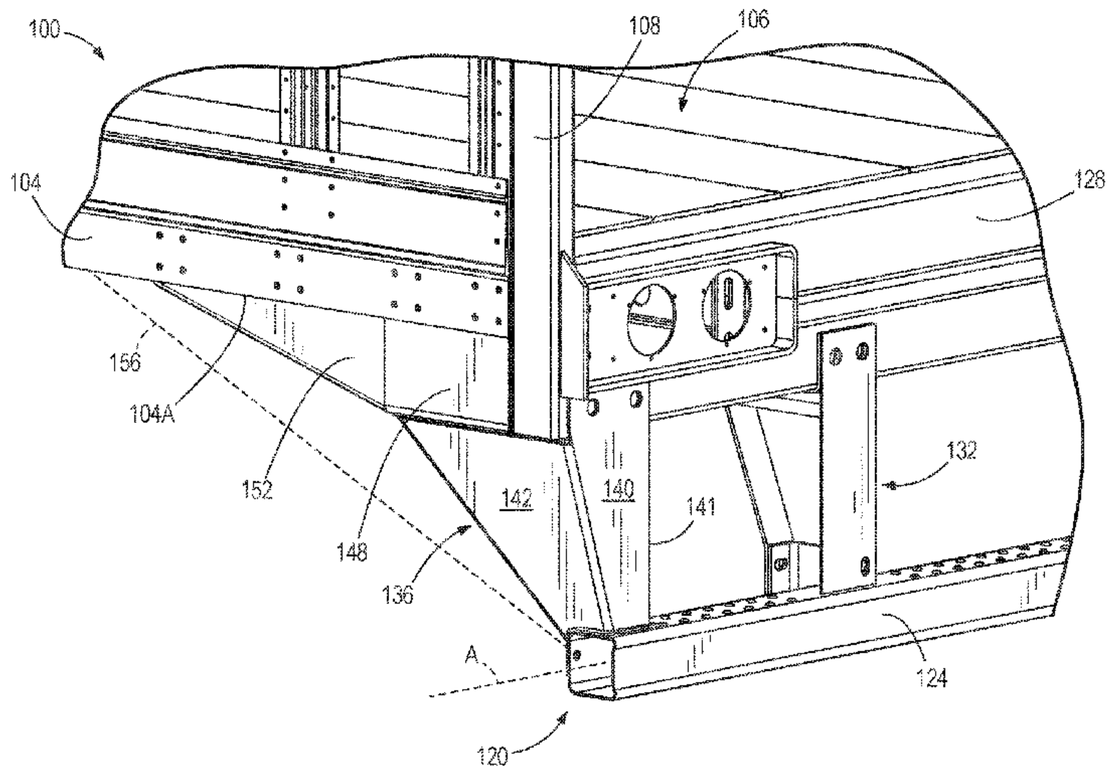
(74) *Attorney, Agent, or Firm* — Michael Best & Friedrich LLP

(57) **ABSTRACT**

A trailer frame includes a rear bolster, cross-members, and corner gussets extending forwardly from ends of the rear bolster. A rear impact guard includes a bumper positioned at the rear end of the trailer and spaced below the rear bolster, pair of outboard posts, and at least one inboard post. The outboard posts extend between the bumper and the rear bolster adjacent respective opposed distal ends of the bumper, and the inboard post extends between the bumper and the rear bolster between the outboard posts. Each of the pair of outboard posts has a lower end that overlaps with a respective mounting bracket that protrudes upwardly toward the rear bolster from the bumper such that mounting holes of the outboard posts align with mounting holes of the mounting brackets. A laterally-outboard panel of each mounting bracket extends obliquely from the bumper in a direction with a laterally-outward component.

20 Claims, 14 Drawing Sheets



Related U.S. Application Data

(60) Provisional application No. 62/311,695, filed on Mar. 22, 2016, provisional application No. 62/206,653, filed on Aug. 18, 2015, provisional application No. 62/206,661, filed on Aug. 18, 2015.

(51) **Int. Cl.**

B62D 25/08	(2006.01)
B62D 33/04	(2006.01)
B62D 53/06	(2006.01)

(58) **Field of Classification Search**

USPC 293/138, 154, 155

See application file for complete search history.

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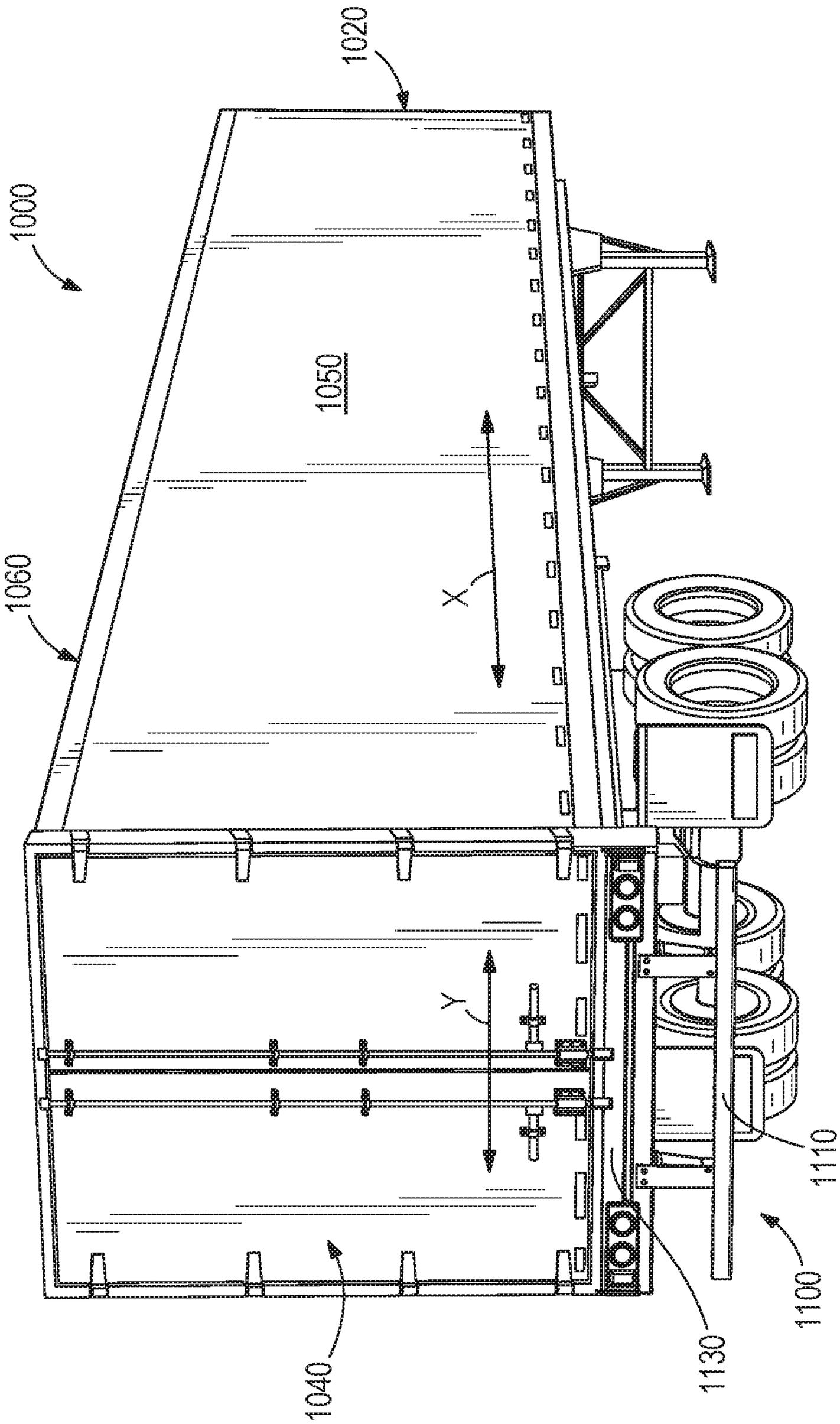
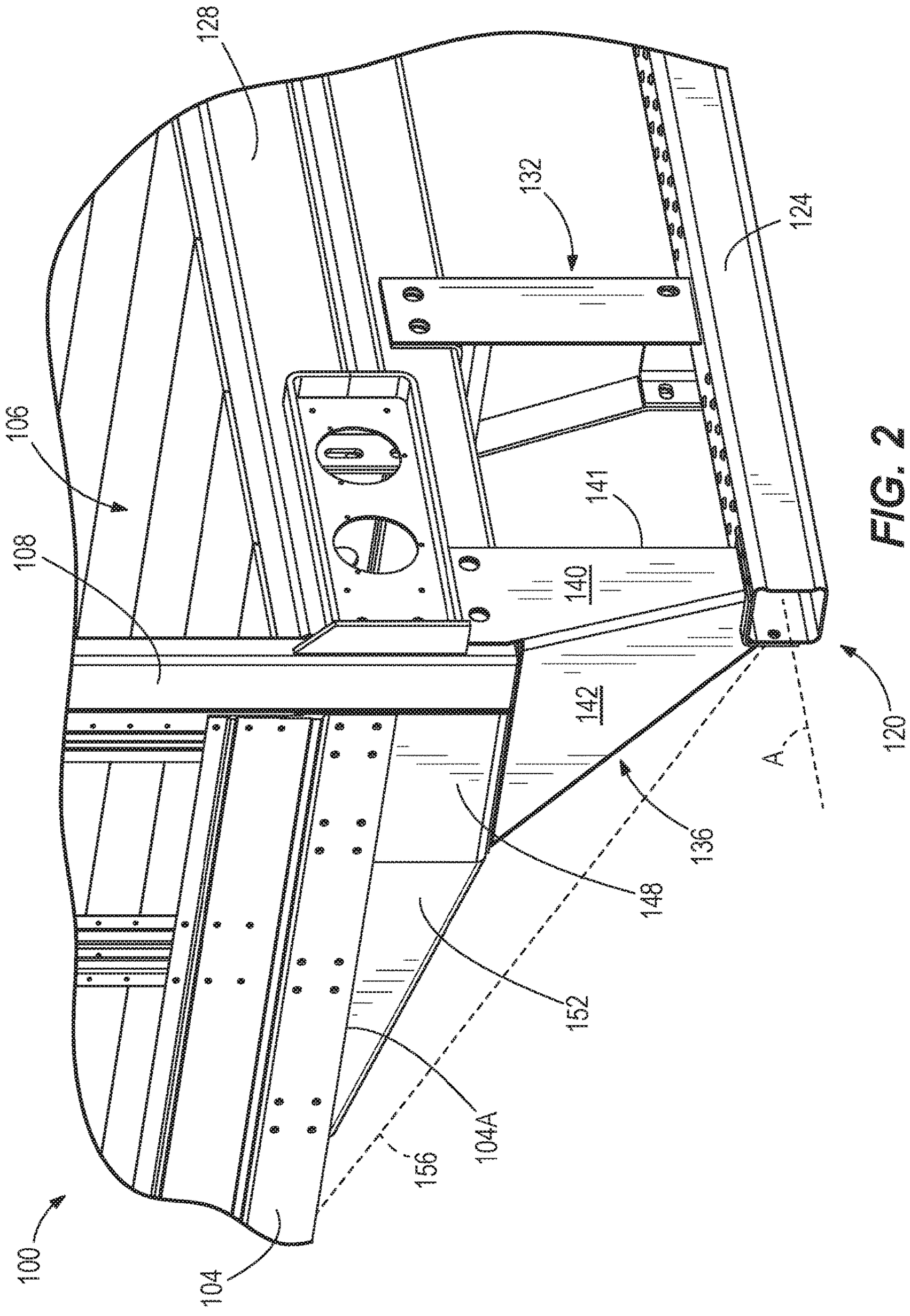


FIG. 1
PRIOR ART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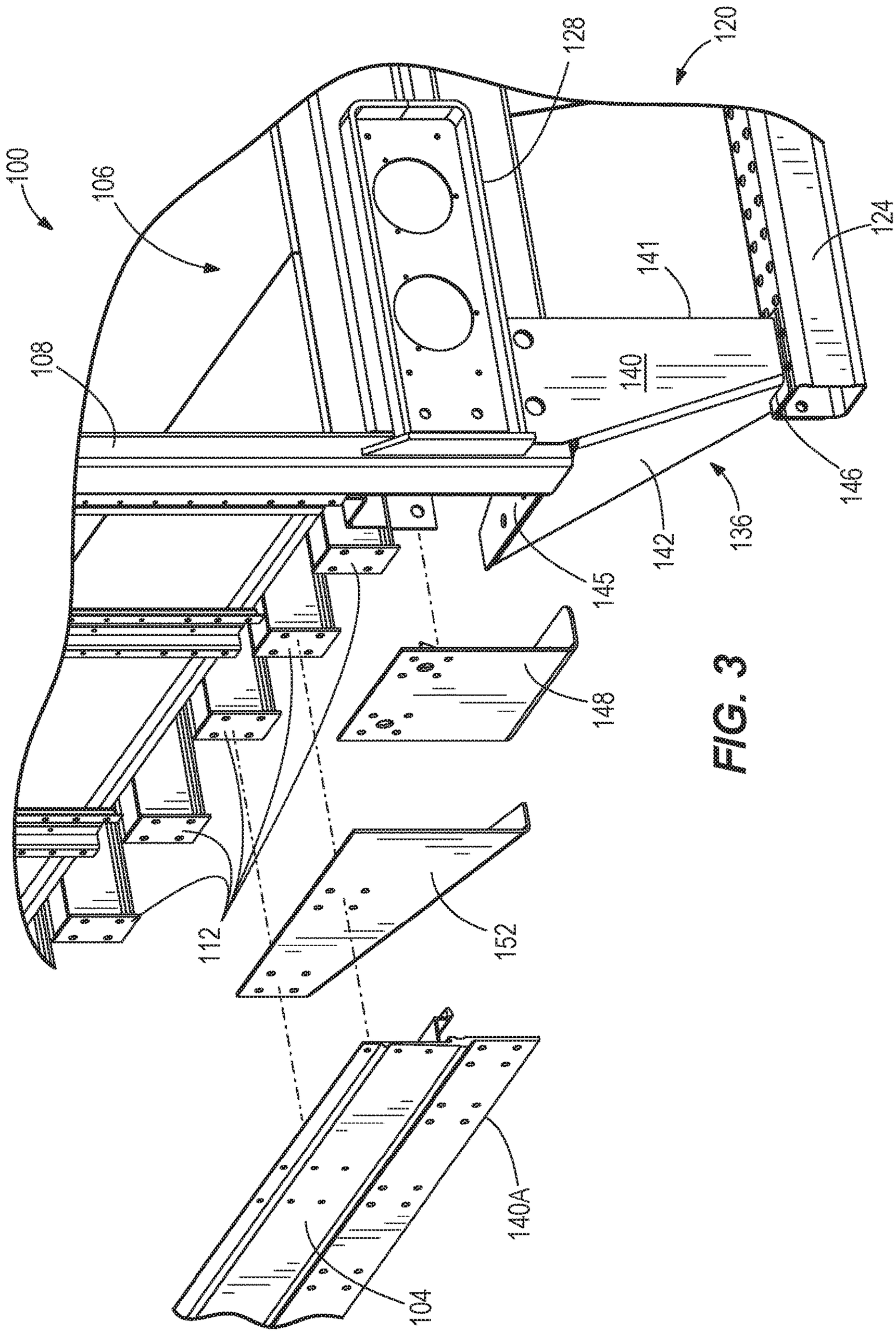
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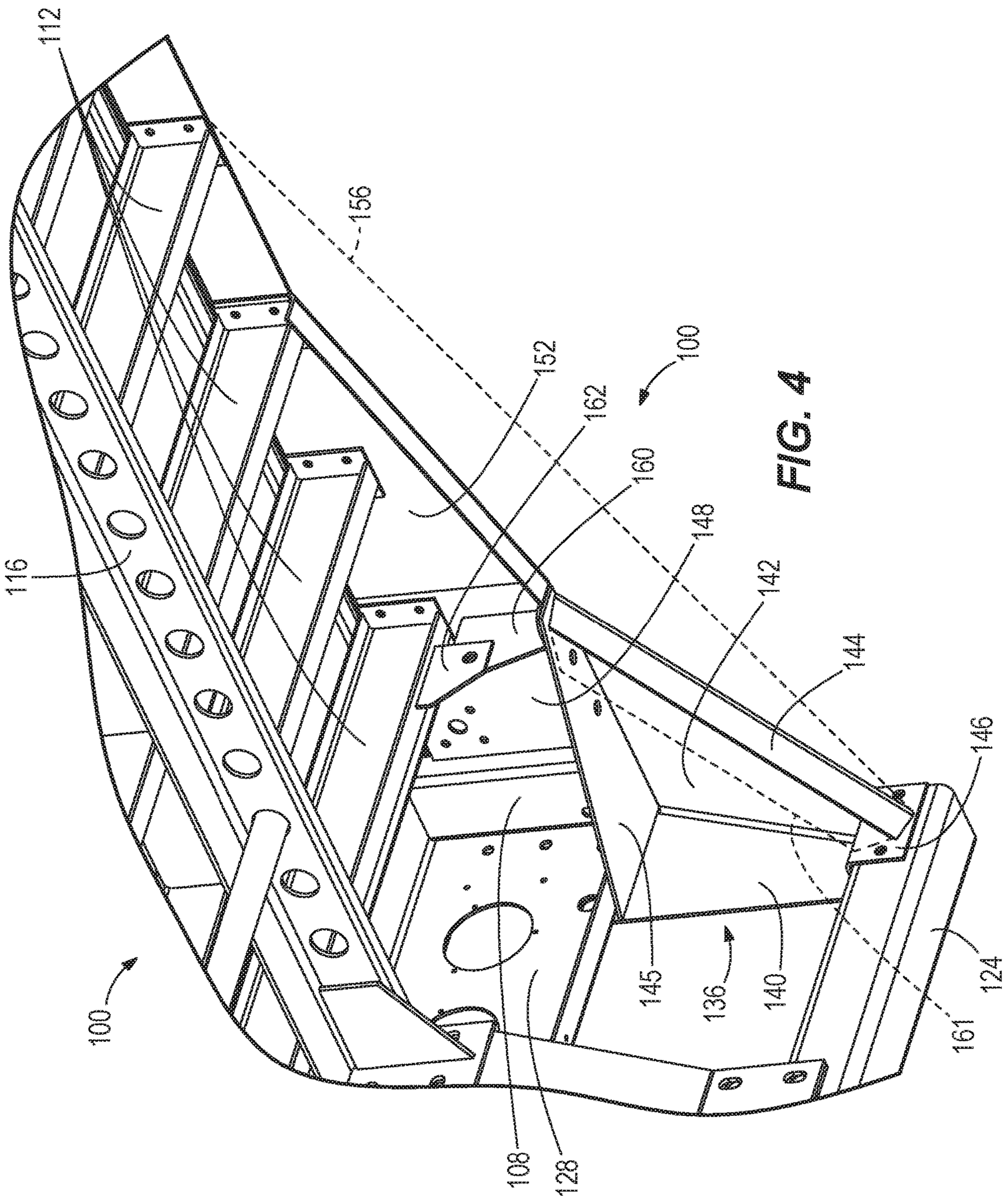
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FIG. 4

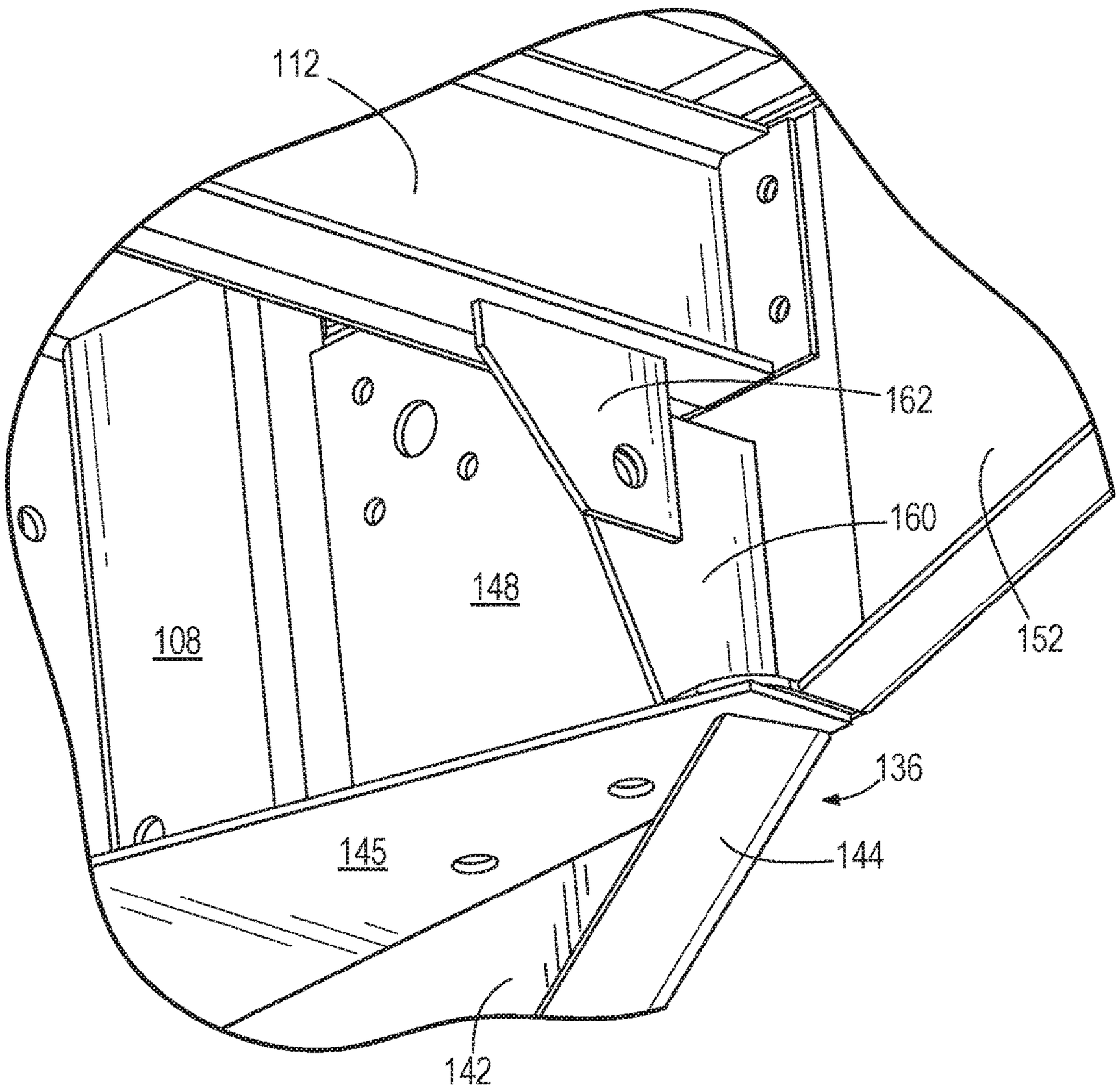


FIG. 5

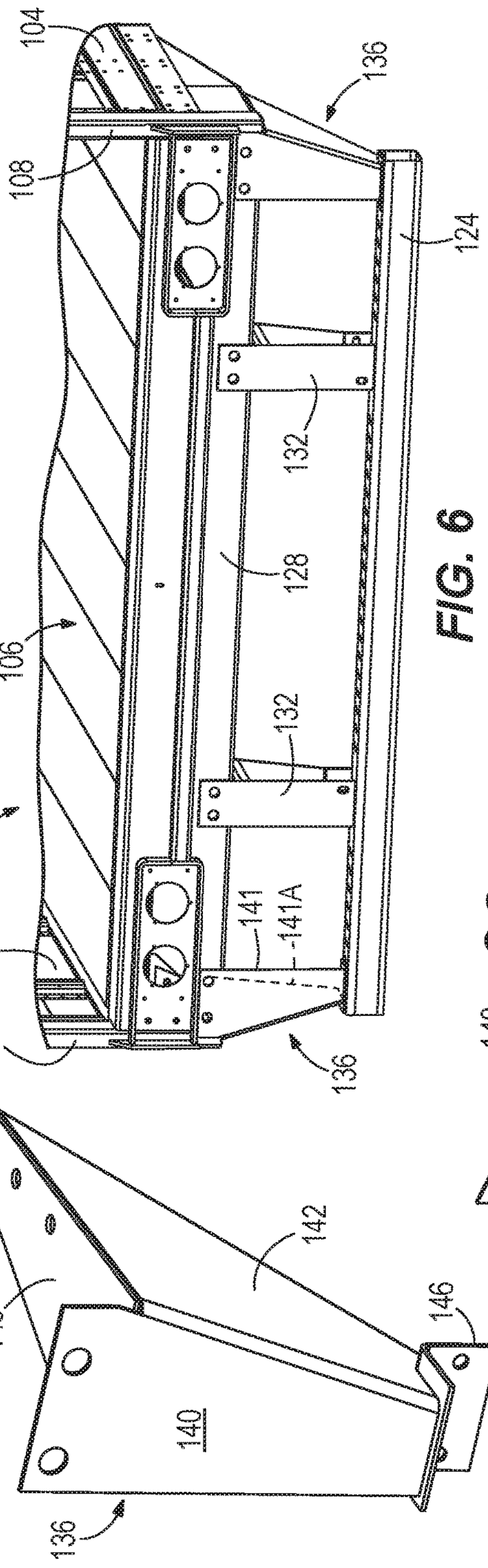


FIG. 6

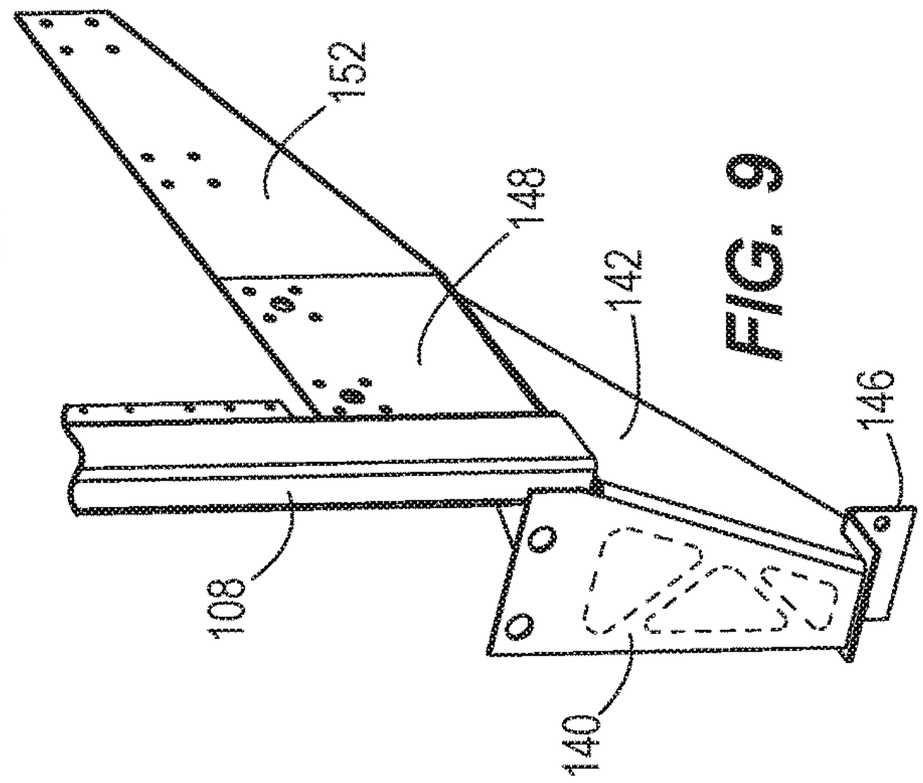
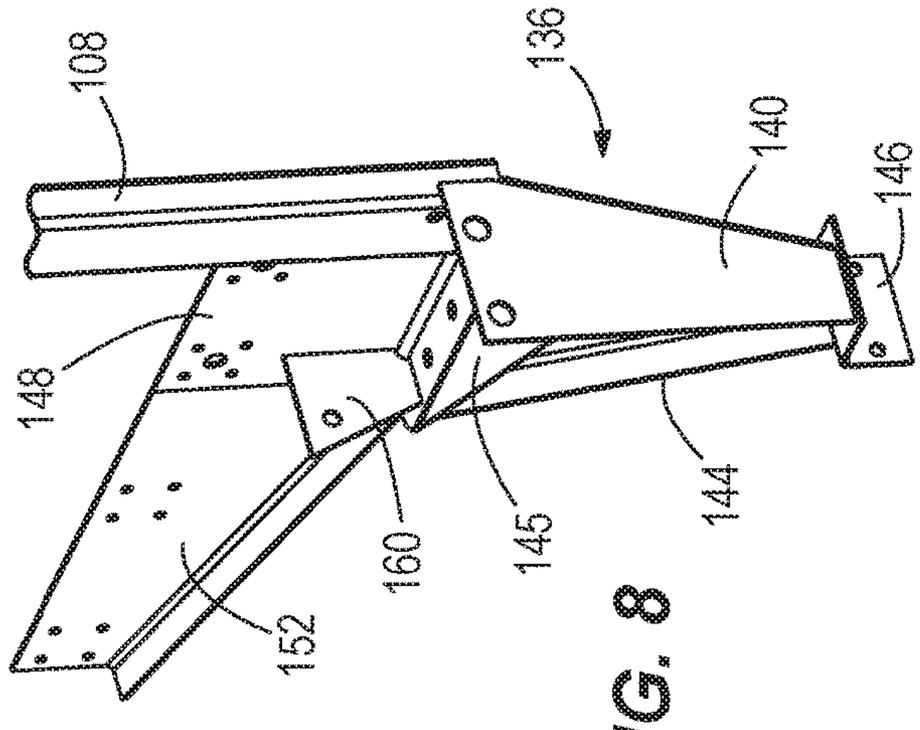


FIG. 9

FIG. 7



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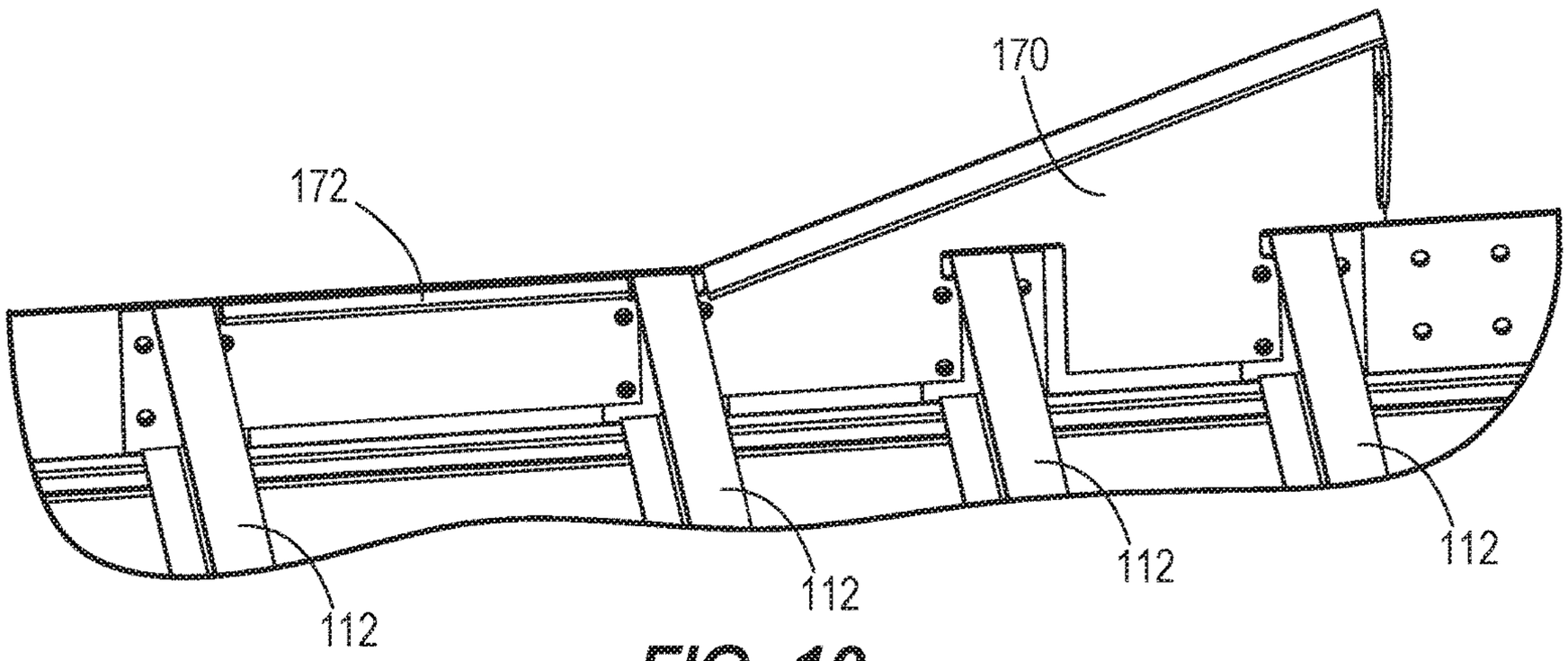

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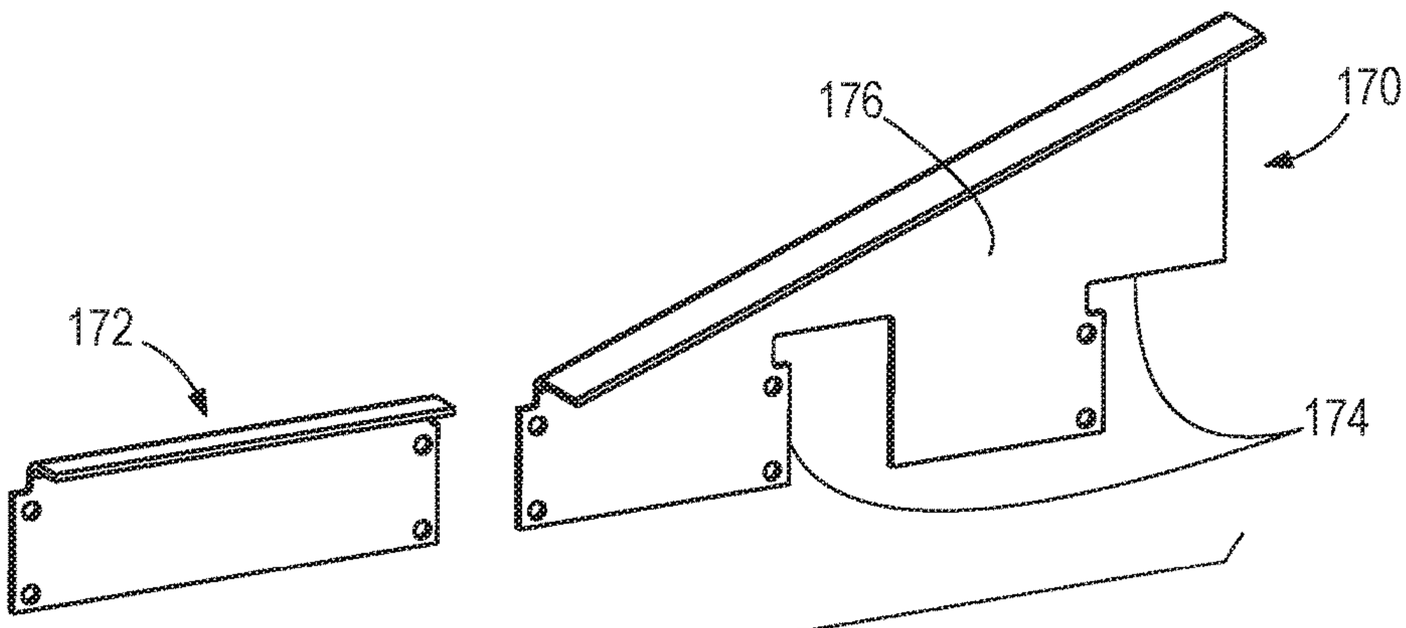

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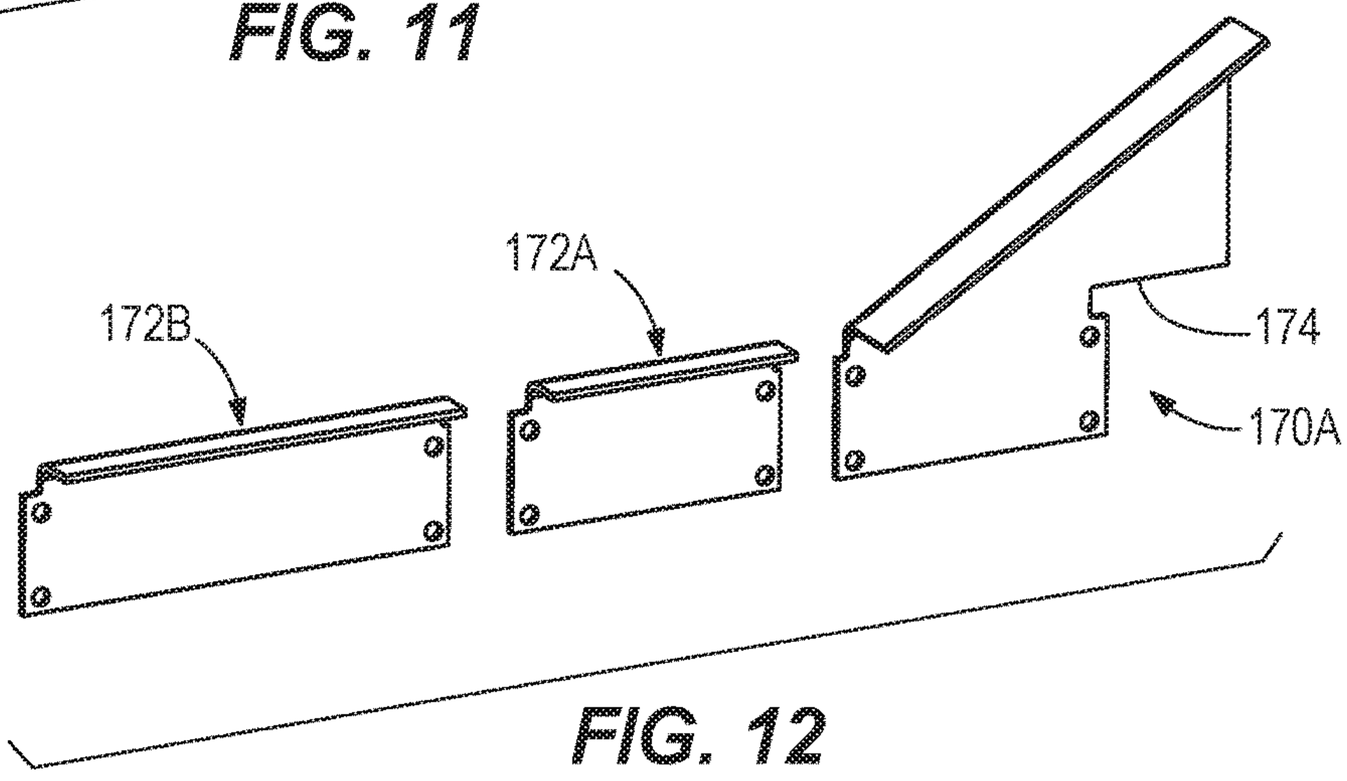

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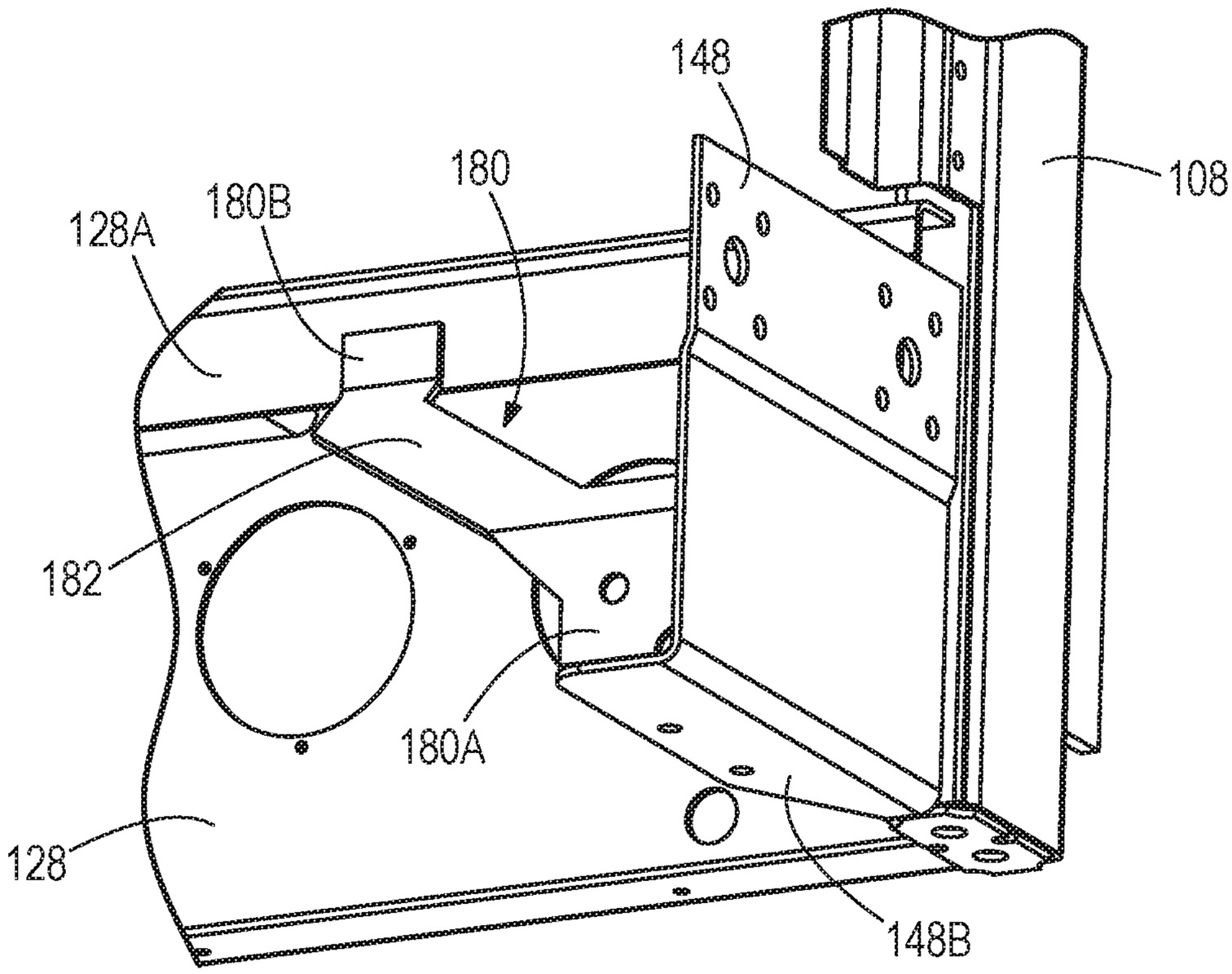
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FIG. 13

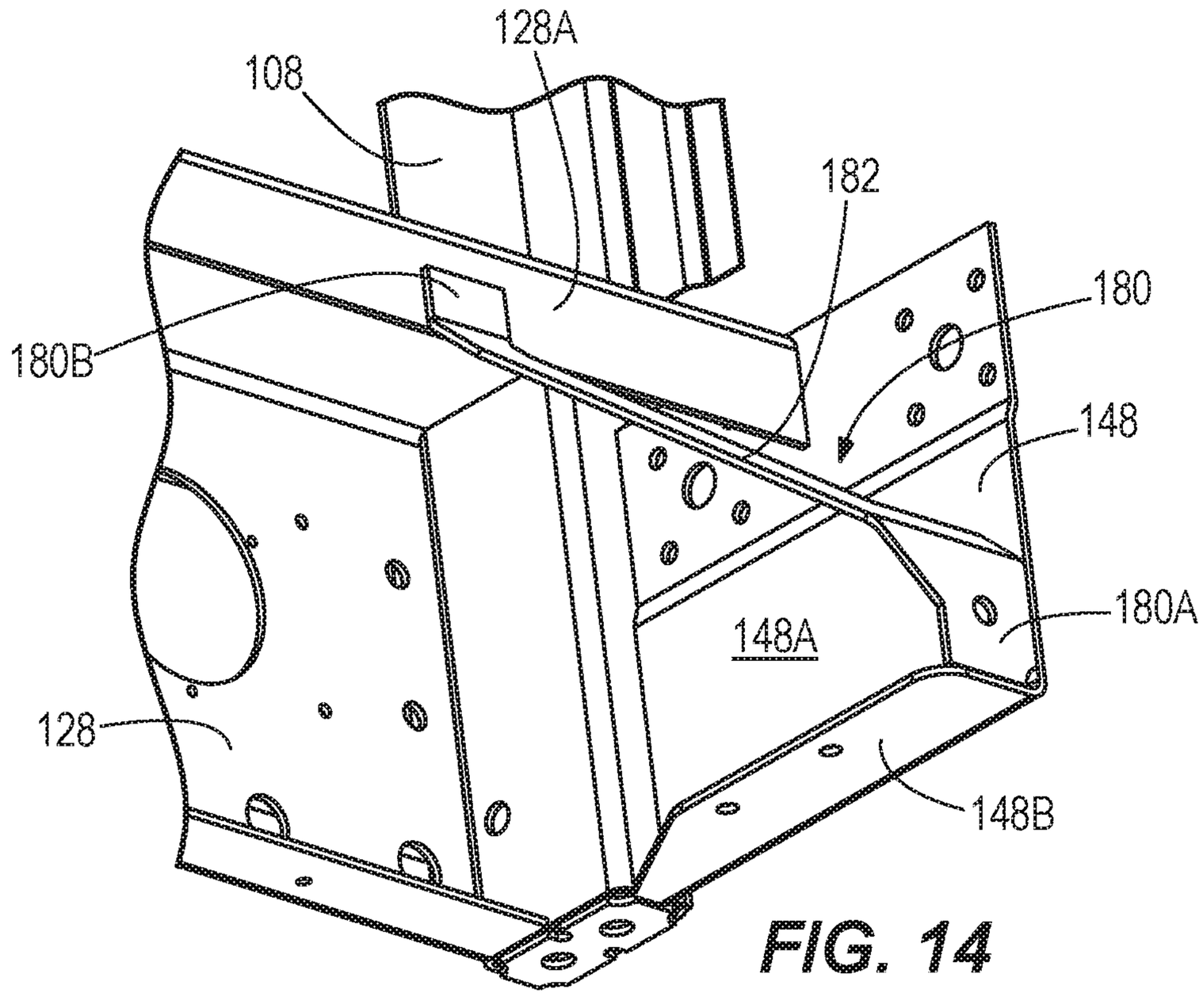
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FIG. 14

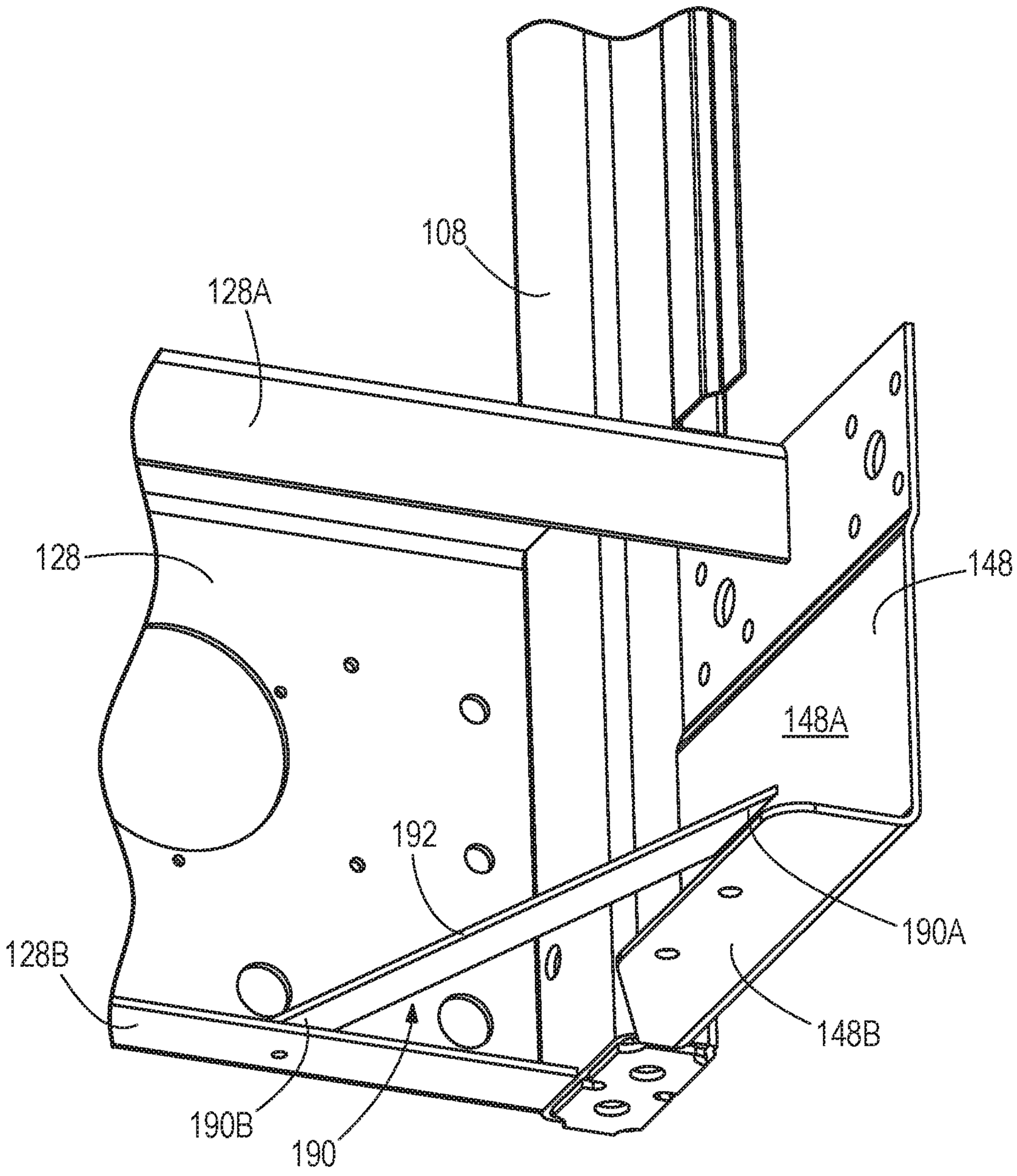

FIG. 15

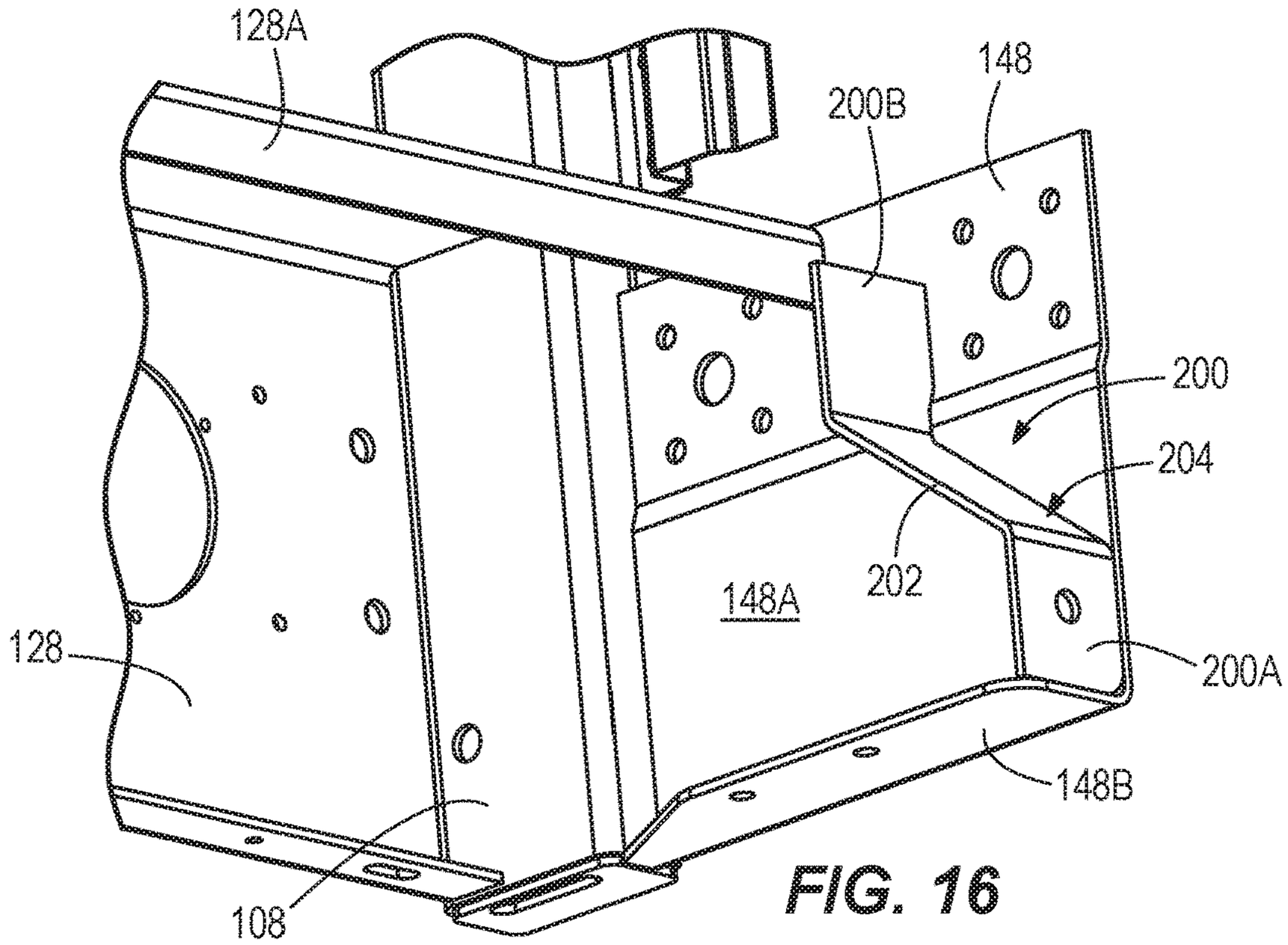
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FIG. 16

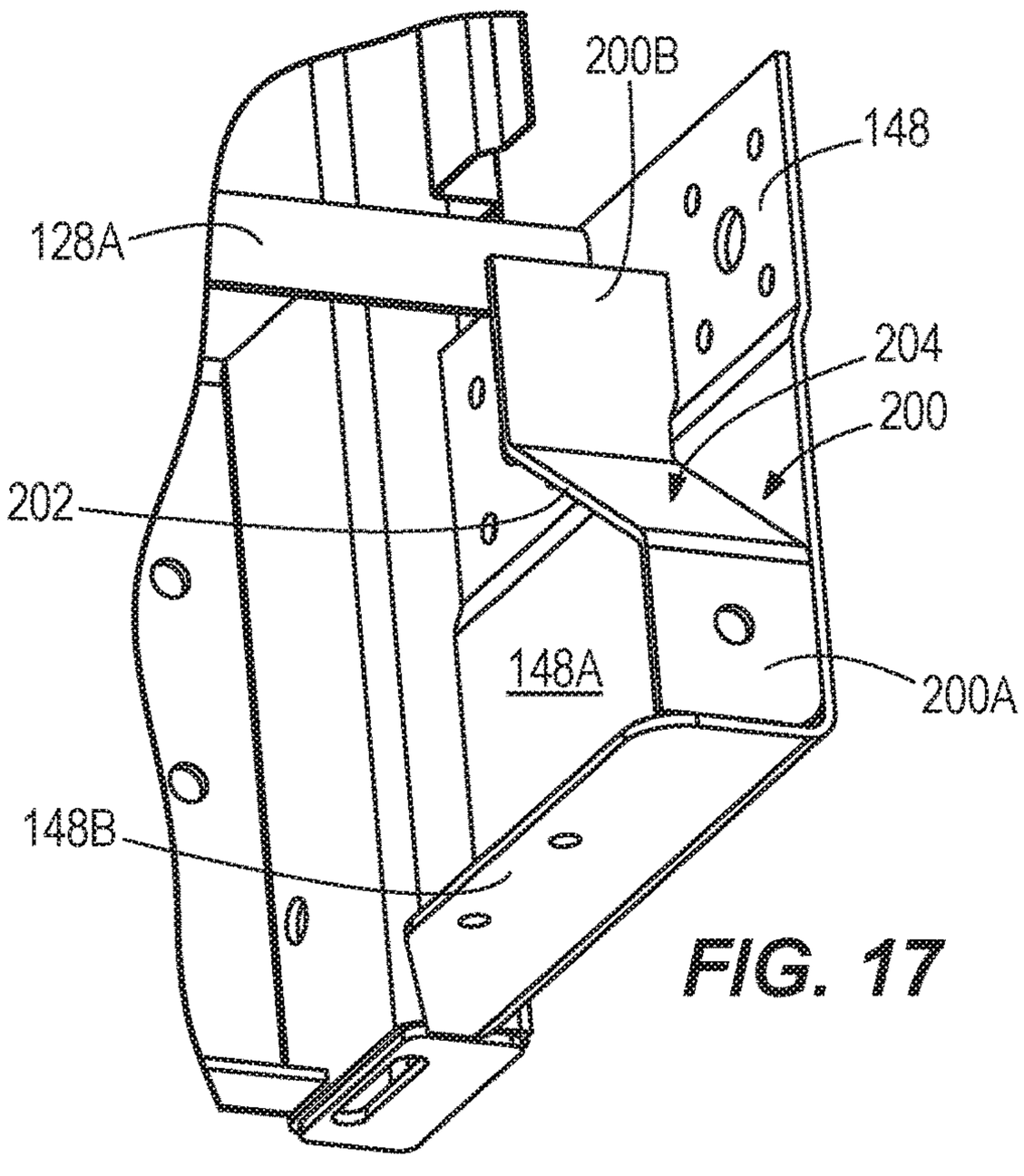
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FIG. 17

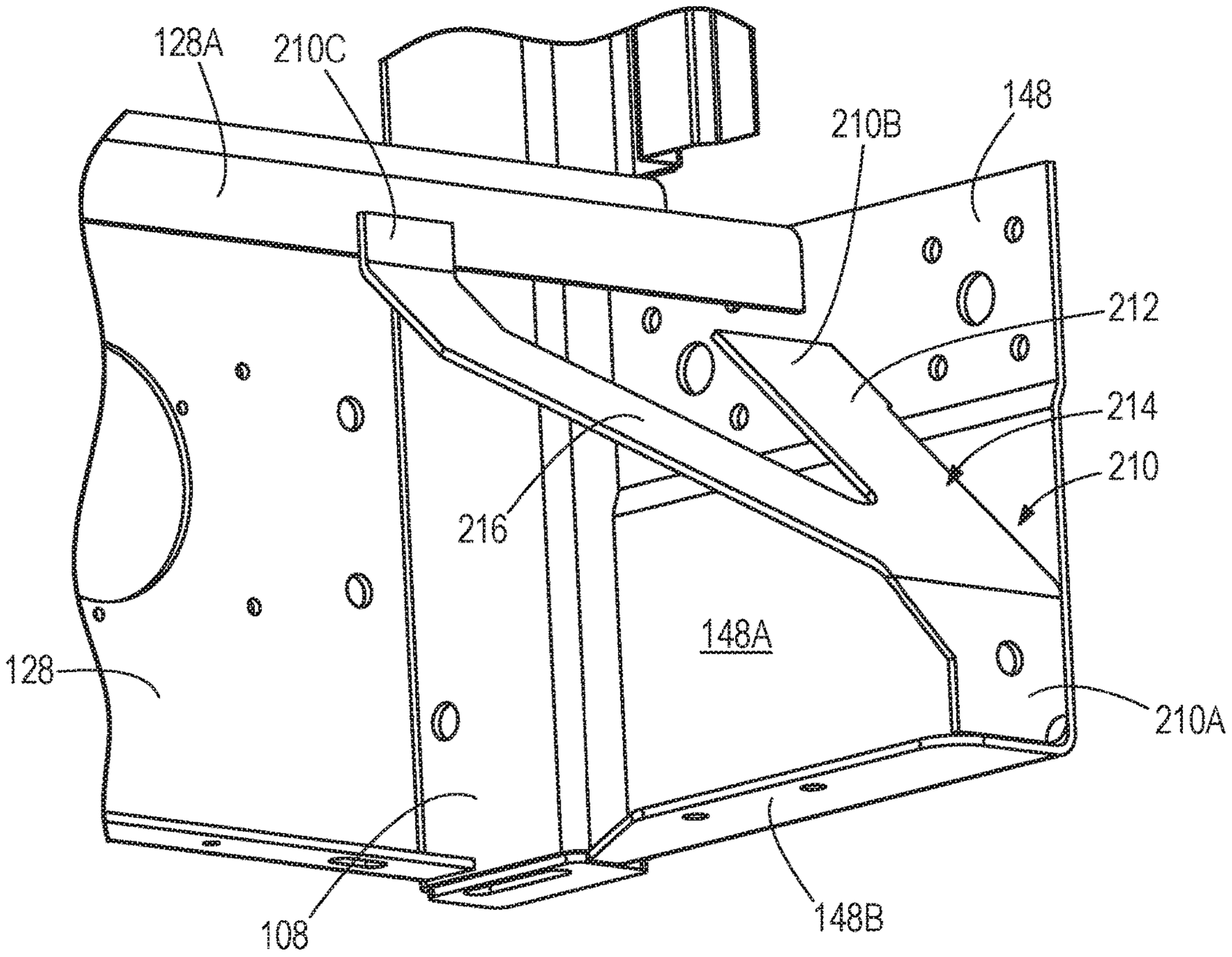


FIG. 18

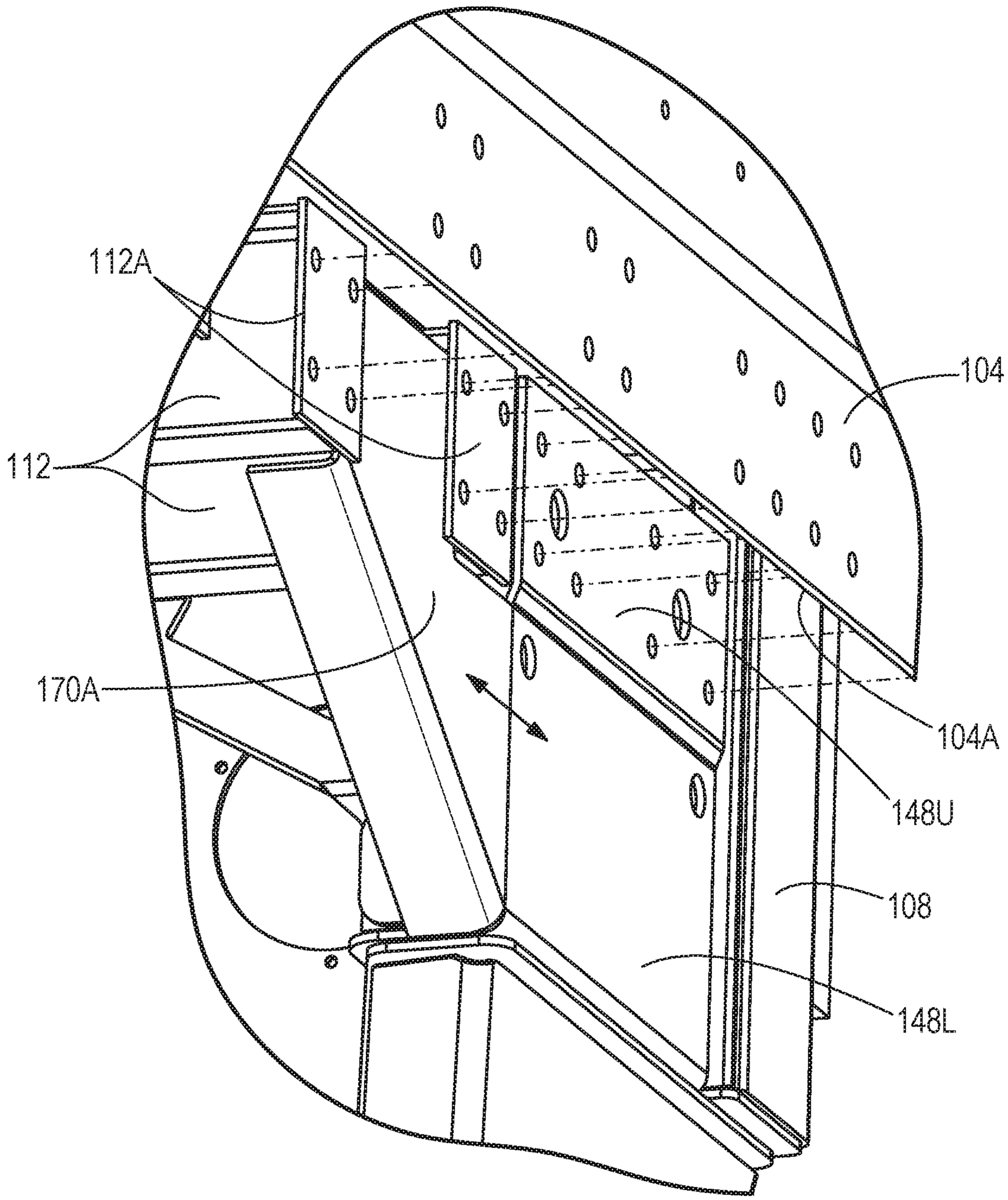


FIG. 19

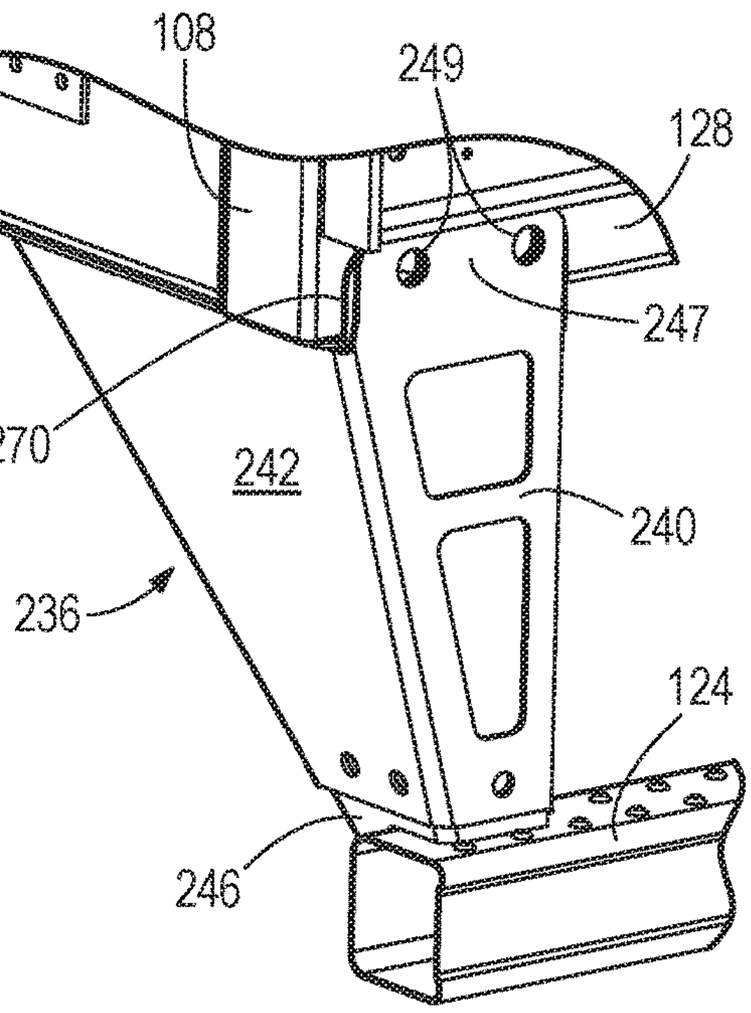


FIG. 20

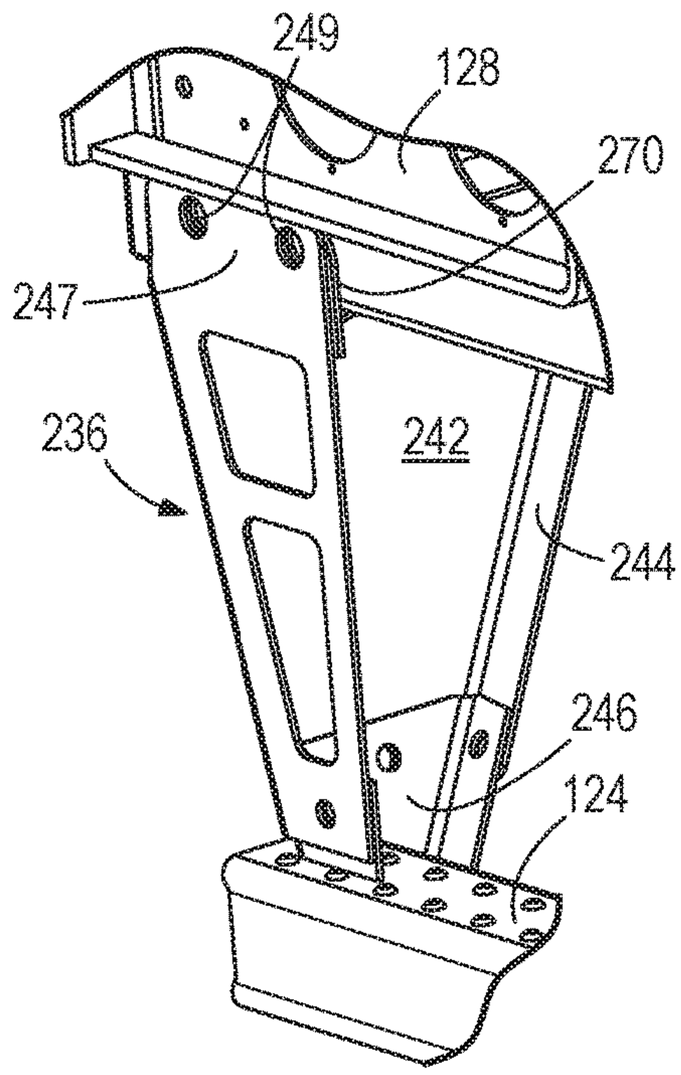


FIG. 21

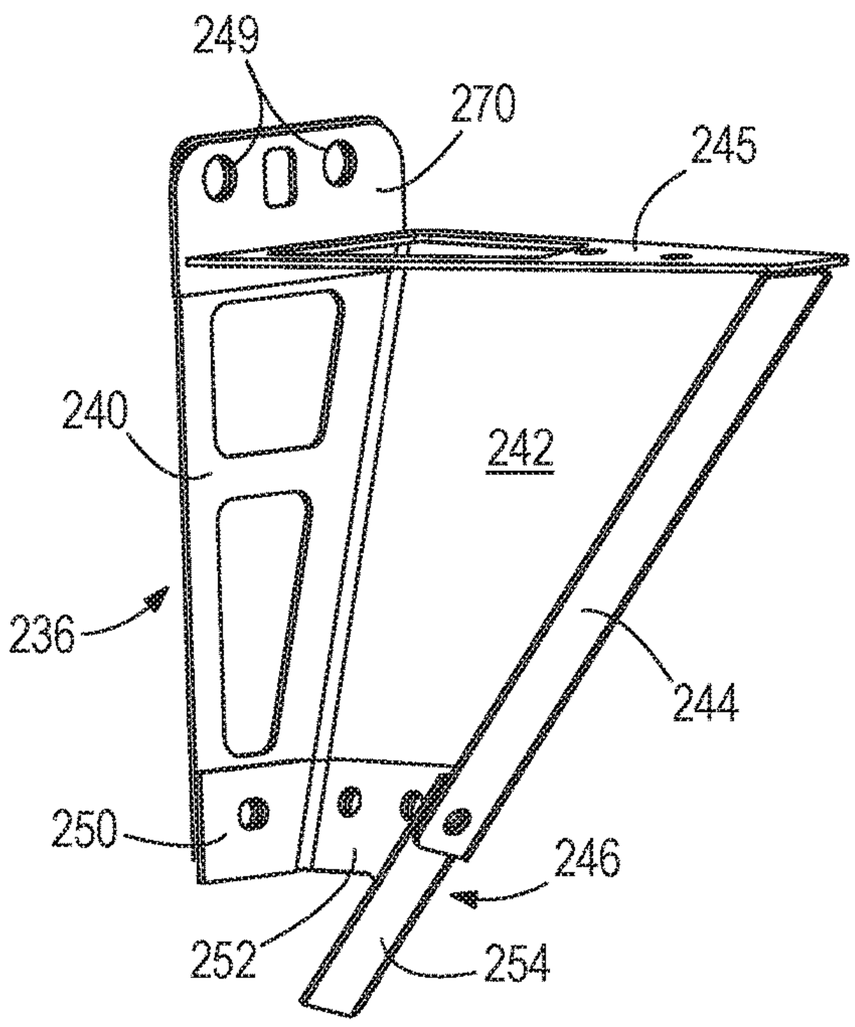
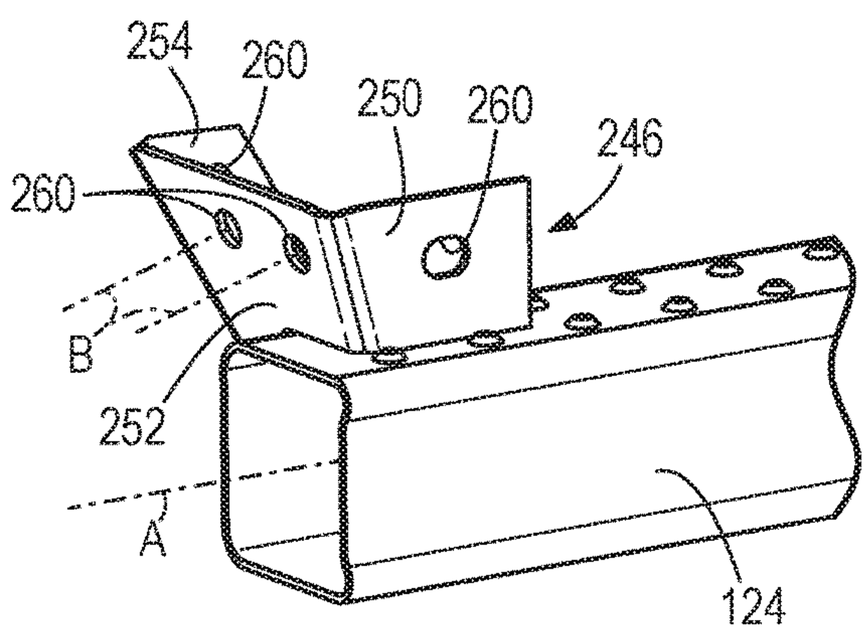


FIG. 22



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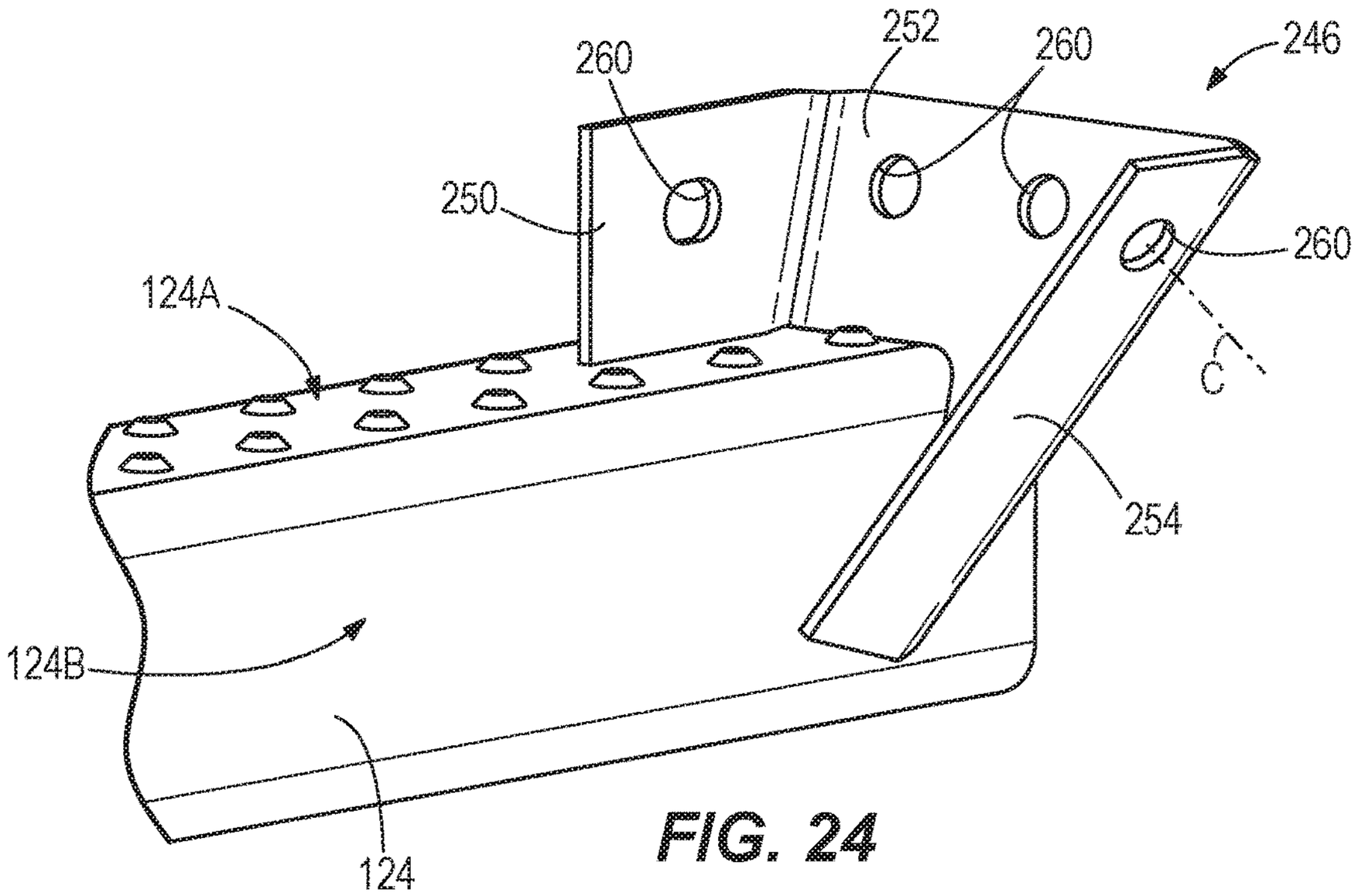
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FIG. 24

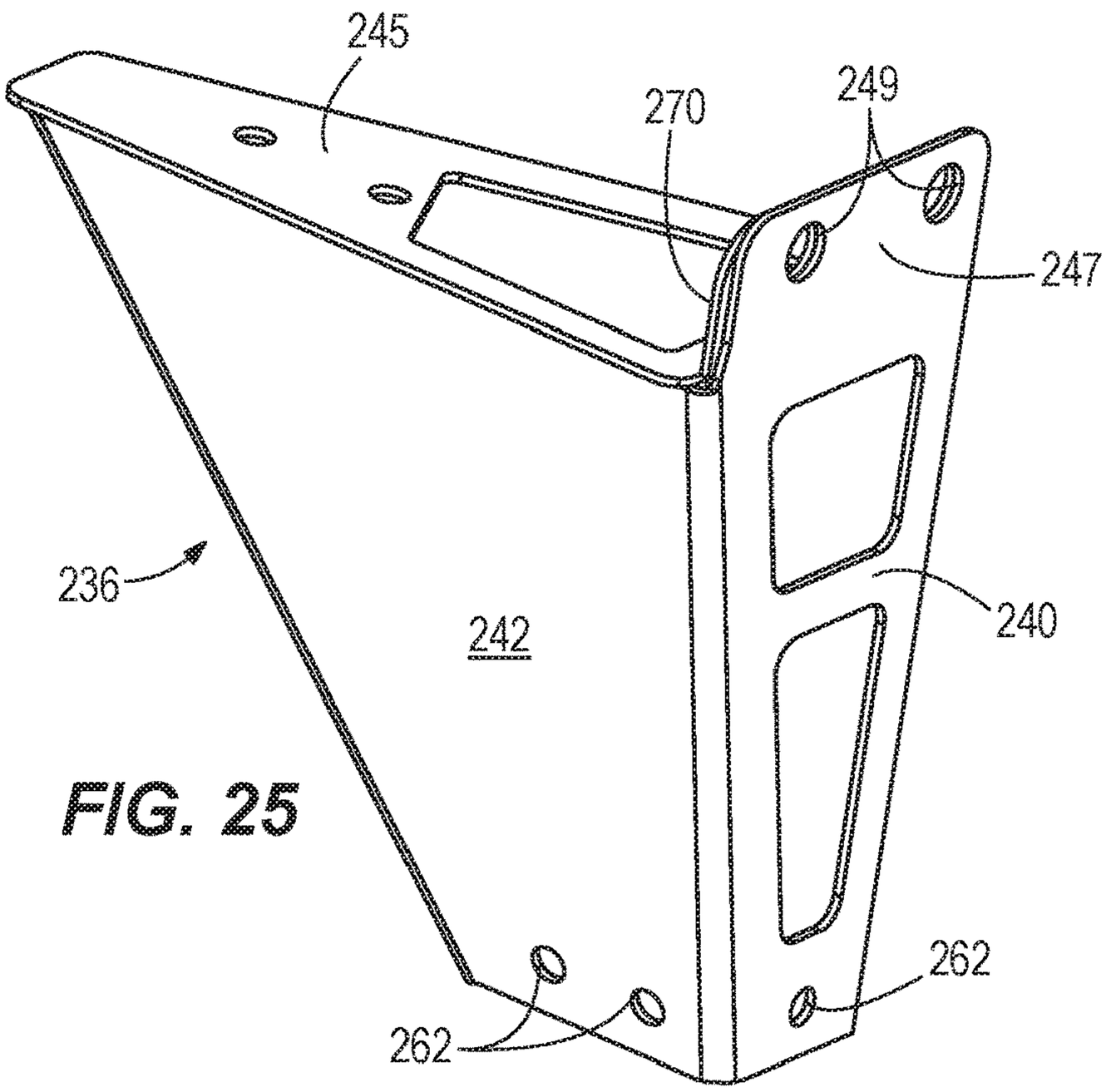
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FIG. 25

TRAILER WITH REAR IMPACT GUARD

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 15/240,237, filed Aug. 18, 2016, issued Sep. 26, 2017 as U.S. Pat. No. 9,771,040, which claims priority to U.S. Provisional Patent Application No. 62/206,653, filed Aug. 18, 2015 and to U.S. Provisional Patent Application No. 62/311,695, filed Mar. 22, 2016, and to U.S. Provisional Patent Application No. 62/206,661, filed Aug. 18, 2015 the entire contents of all of which are incorporated by reference herein.

BACKGROUND

The invention relates to over-the-road trailers and rear impact guards thereof. A conventional trailer **1000** is shown in FIG. **1**, and is configured for over-the-road use with a truck to transport large cargo volumes. The trailer **1000** has a defined front end **1020** adapted for attachment with the truck, and a defined rear end **1040** opposite the front end **1020**. A front-rear, or lengthwise direction X is defined between the front and rear ends **1020**, **1040**, A transverse or lateral direction Y is defined perpendicular to the lengthwise direction X. The lengthwise and lateral directions Y are both parallel to a ground surface along which the trailer **1000** is conveyable. The rear end **1040** in many cases is provided with doors for accessing the cargo area defined between the front and rear ends **1020**, **1040** (and between the sidewalls **1050** and roof **1060**, if so equipped). At the rear end **1040** of the trailer, a rear impact guard **1100** is provided. The rear impact guard **1100** complies with federal mandates for many common types of trailers and is designed to reduce the severity of a crash when a vehicle following the trailer **1000** impacts the rear end **1040** of the trailer **1000**. The rear impact guard **1100** provides a lowered bumper **1110** below the rear sill or rear bolster **1130** at the bottom rear end of the cargo area. However, it may be desirable to further improve safety, especially for off-center impacts, while minimizing cost and weight penalties to the trailer.

SUMMARY

In one aspect, the invention provides a trailer having a front end provided for attachment to a truck, a rear end spaced in a longitudinal direction from the front end to define a cargo area between the front and rear ends, and a frame. The frame includes a rear bolster, a plurality of cross-members, and a pair of corner gussets extending forwardly from respective distal ends of the rear bolster. The rear bolster extends transversely to the longitudinal direction below a bottom rear edge of the cargo area. A rear impact guard of the trailer includes a bumper positioned at the rear end of the trailer and spaced below the rear bolster, pair of outboard posts, and at least one inboard post. The pair of outboard posts extend between the bumper and the rear bolster adjacent respective opposed distal ends of the bumper, and the at least one inboard post extends between the bumper and the rear bolster at a location laterally between the pair of outboard posts. Each of the pair of outboard posts has a lower end that overlaps with a respective mounting bracket that protrudes upwardly toward the rear bolster from the bumper such that mounting holes of the outboard posts align with mounting holes of the mounting brackets. Each mounting bracket has a laterally-outboard panel that extends obliquely from the bumper in a direction with a laterally-outward component.

In another aspect, the invention provides a trailer having a front end provided for attachment to a truck, a rear end spaced in a longitudinal direction from the front end to define a cargo area between the front and rear ends, and a frame. The frame includes a rear bolster, a plurality of cross-members, and a pair of corner gussets extending forwardly from respective distal ends of the rear bolster. The rear bolster extends transversely to the longitudinal direction below a bottom rear edge of the cargo area. The cross-members extend transversely to the longitudinal direction to define a floor structure. A rear impact guard of the trailer includes a bumper positioned at the rear end of the trailer and spaced below the rear bolster, a pair of outboard posts, and at least one inboard post. The outboard posts extend between the bumper and the rear bolster adjacent respective opposed distal ends of the bumper, and the at least one inboard post extends between the bumper and the rear bolster at a location between the pair of outboard posts. Each of the pair of outboard posts is secured at an upper end thereof to a corresponding one of the pair of corner gussets. The pair of corner gussets are fortified with respective lateral reinforcement members, each of which is secured to an interior side of a corresponding one of the pair of corner gussets and each of which extends laterally-inboard from the corresponding corner gusset.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a trailer, according to the prior art.

FIG. **2** is a perspective view of a laterally outer portion of a trailer including a rear impact guard according to one embodiment of the invention.

FIG. **3** is an exploded assembly view of the laterally outer portion of the trailer with rear impact guard of FIG. **2**.

FIG. **4** is a perspective view of the laterally outer portion of the trailer with rear impact guard of FIG. **2**, viewed from underneath the trailer.

FIG. **5** is a perspective view of a supplementary lateral support attachment between the rear impact guard of FIG. **2** and a trailer cross-member.

FIG. **6** is a perspective view of the rear of the trailer having the rear impact guard of FIG. **2**.

FIG. **7** is a rear view of an outer post of the rear impact guard of FIG. **2**.

FIGS. **8** and **9** are perspective views of the outer post of FIG. **7** and a mounting assembly securing an upper end of the outer post to the trailer.

FIG. **10** is a perspective view of a bolt-on rail reinforcement assembly assembled to a trailer frame.

FIG. **11** is a perspective view of bolt-on rail reinforcement elements of FIG. **10** as removed from the trailer frame.

FIG. **12** is a perspective view of a bolt-on rail reinforcement assembly according to another embodiment.

FIGS. **13** and **14** are perspective views of a truss-type lateral support member that extends between the corner gusset and the rear sill.

FIG. **15** is a perspective view of a lateral support member that extends along a horizontal plane between the corner gusset and the rear sill.

FIGS. **16** and **17** are perspective views of a lateral support member that extends along the inside of the corner gusset to the rear sill.

FIG. **18** is a perspective view illustrating a lateral support member that combines aspects of the structure of FIGS. **13-14** with the structure of FIGS. **16-17**.

FIG. **19** is a perspective view illustrating a corner gusset having laterally-offset upper and lower portions so that the vertically-oriented outward-facing surface forms a flush interface with the adjacent rail reinforcement element.

FIG. **20** is a perspective view of a portion of a rear impact guard according to another embodiment in which each outboard post is bolted to a mounting bracket protruding up from the distal end of the bumper.

FIG. **21** is an alternate perspective view of the rear impact guard of FIG. **20**.

FIG. **22** is an alternate perspective view of only the outboard post and the mounting bracket of the rear impact guard of FIG. **20**

FIG. **23** is a perspective view of the bumper and the mounting bracket of the rear impact guard of FIG. **20**.

FIG. **24** is an alternate perspective view of the bumper and the mounting bracket of the rear impact guard of FIG. **20**

FIG. **25** is a perspective view of the corner post of the rear impact guard of FIG. **20**.

DETAILED DESCRIPTION

FIGS. **2-9** illustrate a portion of a trailer **100**, which in some embodiments can be a trailer configured for over-the-road use with a road tractor (e.g., in forming a so-called 18-wheeler) to transport large amounts of cargo. Aspects of the invention may not be limited to such types of trailers however, and it will be understood that features described herein may also apply to many other types of trailers, including those typically having rear impact guards, and others that may not. Similar to that of FIG. **1**, the trailer **100** can include a chassis having axles with multiple sets of wheels. The trailer **100** defines a length in a longitudinal or transport direction between its front and rear ends. The length of the trailer **100** can be 53 feet in some constructions, although the trailer **100** can be manufactured to other lengths greater than or less than 53 feet. Perpendicular to the longitudinal direction, the trailer **100** defines a width and a height. The width cooperates with the length to define a plan view footprint of the trailer **100**, while the height is measured perpendicular to the footprint (which can be perpendicular to the ground). Subtracting for wall thicknesses, the length, the width, and the height cooperate to define a cargo-receiving interior volume of the trailer **100**. The illustrated trailer **100** includes sidewalls, a roof, and a floor, although in other embodiments the trailer only has a floor, or only has a floor and less than four complete sidewalls. While not shown in entirety, the illustrated trailer **100** is an enclosed trailer, but the trailer may be a non-enclosed trailer in other constructions. In any construction, the trailer **100** defines a cargo area operable to receive a load of cargo for transport. Longitudinal top rails and longitudinal bottom rails **104** extend along the length of the trailer **100** at the lateral side edges at the tops and bottoms of the lateral sidewalls, respectively. At a rear of the trailer **100** as shown in FIG. **2**, an opening is provided to selectively access the cargo area for loading and unloading cargo. One or more doors may be provided to selectively close the opening. The trailer **100** also has a load floor **106** for receiving and supporting cargo for transport.

At the rear end of the trailer **100**, two vertically-extending rear frame posts **108** are provided. The rear frame posts **108** define the lateral sides of the opening into the cargo area of the trailer **100**. Along with the longitudinal upper rails, the longitudinal bottom rails **104** terminate at and are secured to the corresponding rear frame posts **108**. The rear frame posts **108** can have a hollow box structure, or other suitable construction. A rear sill or bolster **128** of the trailer frame extends along a bottom rear edge of the cargo area and has two opposing lateral distal ends secured to (e.g., welded to) the two rear frame posts **108**. Below the load floor **106**, a plurality of spaced-apart cross-members **112** or floor joists are provided. The cross-members **112** can be spaced at intervals throughout the entire length of the trailer **100**, each cross-member **112** extending along a respective horizontal axis that is transverse to the longitudinal direction of the trailer **100**. A pair of longitudinally-extending slider rails **116** (one shown in FIG. **4**) extend underneath the cross-members **112** in the rear section of the trailer **100**. The suspension supporting the wheels of the trailer **100** is coupled to the slider rails **116**, allowing a certain amount of movement of the suspension relative to the slider rails **116**. The bottom rails **104**, the rear frame posts **108**, the cross-members **112**, and the slider rails **116**, along with additional components described below form a frame of the trailer **100**.

A rear impact guard **120** is provided at the rear end of the trailer **100** and is secured to the trailer frame. The rear impact guard **120** includes a plurality of elements structurally coupled to the trailer frame generally below the rear opening of the trailer **100**. The rear impact guard **120** can include a bumper **124** extending along a horizontal axis A transversely across the rear of the trailer **100** at a height spaced below the cargo area. The bumper **124** can extend parallel and directly below the rear bolster **128**. The bumper **124** may take any number of constructions, and may be a hollow bumper tube having a circular, rectangular, or square cross-section, among others. The illustrated bumper **124** is of tubular form, and has a modified square cross-section (when viewed along a transverse direction of the trailer **100**, perpendicular to a front-rear direction of the trailer **100**,) with four equal-length sides. The cross-section of the bumper **124** can be consistent throughout its length along an axis A. In the illustrated embodiment, the bumper **124** forms the lowest point of the rear impact guard **120** and extends across the entire width of the trailer **100**, or at least within 100 mm of the lateral extremities of the trailer **100**, although other bumper dimensions are possible. Multiple posts support the bumper **124** relative to the trailer **100**, including at least one inboard posts **132** (e.g., a pair as shown) and a pair of outboard posts **136**. In some embodiments, including the illustrated embodiment, the inboard posts **132** are positioned within the central 70 percent of the width of the bumper **124**, while the outboard posts **136** are positioned at the distal ends of the bumper **124** (e.g., connecting to the bumper **124** outside of the central 90 percent or the central 95 percent of the bumper **124**).

Each of the outboard posts **136** has a similar construction, although each is a mirror image of the other. Details of the outboard posts **136** are described with respect to one of the outboard posts **136**, while it will be understood that these features also apply to the other. The outboard post **136** can be provided with multiple attachment surfaces at its lower end (for attachment to the bumper **124**) and multiple attachment surfaces at its upper end (for attachment to the rear bolster **128**, among other portions of the trailer **100**). Between the upper and lower ends of the outboard post **136**, multiple panels are provided, including at least a rear panel **140** and a laterally outboard panel **142**. The rear panel **140** has an outer surface facing the rear of the trailer **100**, and the laterally outboard panel **142** has an outer surface facing laterally outward. In some embodiments, such as the illus-

trated embodiment, the post **136** further includes a forward panel **144** spaced forwardly of the rear panel **140**. Although not required among all possible constructions, the three panels **140**, **142**, **144** can be integrally formed from a single sheet of material (e.g., bent with two bends) to distinguish the three non-planar panels **140**, **142**, **144**. Any one or more of the panels **140**, **142**, **144** can include one or more apertures, openings, or cutouts for strategic weight relief to minimize the overall weight of the post **136** and the rear impact guard **120**. Dashed lines are used in FIG. **9** to show weight-reducing apertures, according to one exemplary lay-out, that can be provided in the panel **140**. FIGS. **20-22** and **25**, discussed further below, also provide other examples of weight-reducing apertures.

As shown in FIG. **4**, the outboard post **136** can further include a gusset **145** positioned at the upper portion and secured (e.g., via welding, folding of material common to any or all of the panels **140**, **142**, **144**, and the like) with the panels **140**, **142**, **144** to further strengthen the post and provide a mounting location as discussed below. At a lower end, the outboard post **136** is provided with a mounting bracket **146** for attachment to the bumper **124**. The mounting bracket **146** can be secured (e.g., via welding, folding of material common to any or all of the panels **140**, **142**, **144**, and the like) to one, two or all of the panels **140**, **142**, **144**. In some embodiments, the mounting bracket **146** has a non-flat shape that conforms to a portion of an outer surface of the bumper **124**. The mounting bracket **146** can be a plate of uniform thickness (e.g., formed by bending a flat plate), such that the bottom ends of the panels **140**, **142**, **144** also generally conform to the non-flat shape of the outer surface of the bumper **124** as shown in FIGS. **10-12**. In this manner, the mounting bracket **146** can extend to and be secured to multiple sides (e.g., top and forwardly-facing side, as shown in FIG. **4** by way of example) of the bumper **124**. In other embodiments, the mounting bracket **146** is secured to only a single side of the bumper **124**, such as only to a top side of the bumper **124** or to a forwardly-facing side of the bumper **124**. Also, in some alternative embodiments, the mounting bracket **146** is defined in whole or in part by the bottom ends of the panels **140**, **142**, **144**, which can be shaped as described above to contact and be secured to one or more sides of the bumper **124** as also described above.

As shown in FIG. **2**, the rear frame post **108** extends lower than the bottom rail **104**. A corner gusset **148** of the trailer frame is secured to the rear frame post **108**, and the bottom rail **104** and/or at least one of the cross-members **112** to occupy the space forward of the bottom end of the rear frame post **108** and below the rear end of the bottom rail **104**. As described below, the corner gusset **148** provides a mounting location for attachment of the outboard post **136** to mount the rear impact guard **120** to the trailer **100**.

In some embodiments, such as in the illustrated embodiment, a reinforcement member **152** extends directly forward from the corner gusset **148** along bottom half of the bottom rail **104**, and extending below a bottom edge **104**A of the bottom rail **104**. The illustrated reinforcement member **152** has a triangular side profile that tapers in height toward the forward end, although other shapes are possible while still being attached to the other portions of the trailer frame described below. With reference again to the illustrated embodiment, in some embodiments the height at the rear end of the reinforcement member **152** matches that of the corner gusset **148**. However, the reinforcement member **152**, or an additional aerodynamic panel, may be provided in the profile indicated by the dashed lines **156** in FIGS. **2** and **4**. Each of the corner gusset **148** and the reinforcement member **152** can have an L-shaped cross-section as seen in FIGS. **3** and **8**, among others. As shown in FIGS. **4-5**, a gusset **160** perpendicular to both portions of the L-shaped corner gusset **148** is fixed (e.g., welded) to the corner gusset **148** to provide additional rigidity, particularly in the lateral direction. Likewise, a gusset **162** can be fixed (e.g., welded) to the cross-member **112** adjacent the corner gusset **148**, and/or can be secured to the gusset **160** of the corner gusset **148** via a removable fastener, such as one or more bolts. However, lateral stiffness may be supplemented in alternate ways with one or more gussets at this location or others, coupled with removable fasteners or in a permanent manner such as welding. In another example, the corner gusset can be provided with a U-shaped cross-section so that a vertically-extending inboard panel is parallel to and spaced from the vertically-extending outboard panel, with a bottom panel connected therebetween. One or more internal gussets can be provided between the panels that form the "U" shape of such a corner gusset. The outboard panel can extend to a height greater than that of the inboard panel for connection to the end or ends of at least one cross-member **112** and the bottom rail **104** of the trailer **100**, while the inboard panel extends up into contact with a bottom surface of one or more of the cross-members **112**.

The outboard post **136** has an upper portion that wraps around the lower rear corner of the trailer frame to connect to the trailer frame directly inboard of the rear frame post **108** and directly forward of the rear frame post **108**. With continued reference to the illustrated embodiment, a first upper edge of the outboard post **136** extends along and is secured to a rear-facing surface of the rear bolster **128**, and a second upper edge portion of the outboard post **136** extends longitudinally along and is secured to the corner gusset **148** along a laterally outer edge of the trailer frame. This arrangement can utilize two separate mounting locations, each configured for attachment to the trailer frame with at least one removable fastener (e.g., bolts), although permanent manner of fastening (e.g., welding) are possible. In the illustrated embodiment, the first mounting location at the upper portion of the first panel **140** includes two laterally-spaced bolt holes. The second mounting location, at the gusset **145**, includes two longitudinally-spaced bolt holes. As shown in FIGS. **8** and **9**, the outboard post **136**, in the area of the first mounting location, can form a flange that overlaps and abuts a rear-facing surface of one or both of the rear frame post **108** and the rear bolster **128**. The outboard post **136**, in the area of the second mounting location formed by the gusset **145** at the upper end, can abut a bottom end of the rear frame post **108**. The outboard post **136** can be releasably (e.g., bolts) or permanently (e.g., welding) attached to the rear frame post **108** at either or both of these locations. Additionally, the upper horizontally-lying surface of the gusset **145** may abut corresponding bottom ends of any or all of the rear bolster **128**, the rear frame post **108**, and the corner gusset **148**. The outboard post **136** can be releasably (e.g., bolts) or permanently (e.g., welding) attached to the rear bolster **128**, the rear frame post **108**, and/or the corner gusset **148** at any or all of these locations.

As mentioned above, the illustrated outboard post **136** has a lower portion that at least partially wraps around the bumper **124**. For example, the mounting bracket **146** at the lower end of the illustrated outboard post **136** extends along a top surface of the bumper **124** and extends along a forward-facing surface of the bumper **124**. Multiple mounting locations are provided by the mounting bracket **146** (e.g., holes for receiving removable fasteners such as bolts). For example, a first mounting hole is provided in the portion of

the mounting bracket **146** engaging the top of the bumper **124** and a pair of mounting holes are provided in the portion of the mounting bracket **146** engaging the forward-facing surface of the bumper **124**.

As described, the design of the outboard posts **136** allows the outboard post **136** to be provided to the trailer frame in a bolt-on manner, and further allows the bumper **124** to be provided to the outboard posts **136** in a bolt-on manner. As shown in the accompanying drawing views, the inboard post(s) **132** can also be provided as bolt-on components between the trailer frame and the bumper **124**. However, in an alternate embodiment, some or all of the connections between the posts **132**, **136** and the trailer frame and/or between the posts **132**, **136** and the bumper **124** may be of a permanent, non-removable type such as welding ("non-removable" referring to the inability to remove without damage or destruction). For example, the lower ends of the outboard posts **136** (and optionally, the inboard posts **132**) can be welded directly to the bumper **124**. In such embodiments, the mounting bracket **146** may be omitted, and the panels **140**, **142**, **144** may be welded directly to the bumper **124**. The general shape of the lower end of the outboard post **136** can be the same as described above to wrap around the bumper **124**. If the lower end of the outboard post **136** is welded, but the upper end of the outboard post **136** (and each inboard post **132**) retains a bolt-on arrangement, the rear impact guard **120** as a whole can be provided in a bolt-on manner to the trailer frame. By limiting the amount of components of the rear impact guard **120** that are made integral with the trailer frame, the rear impact guard **120** and/or components thereof may be serviceable in the field with minimal time and cost, and minimal risk of damaging the trailer. For example, in the event of cosmetic or minimal damage to an outboard post **136** or to the bumper **124**, the individual component (or the rear impact guard **120** as a whole) may be removed by simply removing bolted connections, and can then be replaced. Although bolts and nuts may be utilized throughout the rear impact guard **120** as shown and described, it will be understood that other types of threaded fasteners may instead be utilized, as can any other type of removable fastener. In this regard, as used herein and in the appended claims the term "bolt-on" shall not be interpreted as limiting specifically to the use of bolts.

As shown in at least FIGS. **2** and **3**, the outer post **136** has an inboard edge **141**, formed by the rear panel **140**, and the inboard edge **141** extends vertically. In particular, the inboard edge **141** has no lateral taper as viewed from the rear, and is extended in a vertical direction perpendicular to the bumper **124**. However, as indicated at the left side of FIG. **6**, the outboard post **136** can include a tapered inboard edge **141**A that extends gradually more laterally outboard along a downward extent toward the bumper **124**. As such, the tapered inboard edge **141**A can form an obtuse angle with the rear bolster **128** in rear view, while an acute angle is formed in rear view between the inboard edge **141**A and the bumper **124**. This design can be incorporated on both outboard posts **136**, despite only being illustrated on the left side in FIG. **6**. Further, the tapered inboard edge **141**A. can be combined with other aspects and embodiments of the invention disclosed herein.

Further features, usable together or alone in combination with a rear impact guard as described above, are illustrated in FIGS. **10** to **25** and discussed below.

FIGS. **10** and **11** illustrate a bolt-on rail reinforcement assembly including a primary reinforcement member **170** and a secondary reinforcement member **172** that is longitudinally spaced from and aligned with the primary reinforcement member **170**. The primary reinforcement member **170** generally replaces the reinforcement member **152** as shown in FIGS. **1-5**. However, whereas the ends of the cross-members **112** abut with the reinforcement member **152** of FIGS. **1-5**, the primary reinforcement member **170** of FIGS. **10** and **11** features recesses **174** that receive the ends of the cross-members **112** so that the primary reinforcement member **170** form-fits around one or more of the cross-members **112**. As such, a pre-standardized cross-member length (in the lateral trailer direction) can be used throughout the trailer, avoiding customized, shorter-length cross-members at the rear end of the trailer that is reinforced for the rear impact guard. The design of the reinforcement members **170**, **172**. also allows installation at any given point in the assembly process, and does not require installation at the time of connection between the bottom rail **104** and the cross-members **112**, since the reinforcement members **170**, **172** are not sandwiched between the bottom rail **104** and the ends of the cross-members **112**. A triangular gusset portion **176** of the primary reinforcement member **170** is provided to extend below the bottom rail **104**, similar to the reinforcement member **152** of FIGS. **1-5**. The primary reinforcement member **170** can be provided with mounting holes to be secured with fasteners to the bottom rail **104** along with the cross-members **112**. The optional secondary reinforcement member **172** is positioned forward of the primary reinforcement member **170**, and is provided with a size and shape that fits between two adjacent cross-members **112**. The secondary reinforcement member **172** can be entirely nested between the cross-members **112**, with no gusset portion extending below the cross-members **112** or the bottom rail **104**. The secondary reinforcement member **172** provides a reinforced connection between the two adjacent cross-members **112**, alongside the bottom rail **104**. FIG. **12** illustrates an alternate bolt-on rail reinforcement assembly in which a primary reinforcement member **170**A is provided with a single recess **174**, rather than two recesses **174**, and the primary reinforcement member **170**A has a shorter length that that of FIGS. **10-11**. One or more secondary reinforcement members **172**A, **172**B can be provided forward of the primary reinforcement member **170**A so that the total reinforced length can match that of FIGS. **10-11**, even with a shorter primary reinforcement member **170**A. The secondary reinforcement members **172**A, **172**B can be of uneven lengths to accommodate the existing cross-member spacing.

FIG. **19** illustrates the primary reinforcement member **170**A of FIG. **12** from the exterior side of the trailer, showing how the primary reinforcement member **170**A extends between adjacent cross-members **112**, without extending between the end of any cross-member **112** and the bottom rail **104**, which is shown laterally-exploded in FIG. **19**. Because the primary reinforcement members **170**, **170**A of FIGS. **10-12** do not extend laterally past the ends of the cross-members **112**, but a portion of the corner gusset **148** does extend laterally past the ends of the cross-members **112**, a potential misalignment may occur between the laterally outboard surfaces of the corner gusset **148** and the primary reinforcement member **170**, **170**A that are exposed below the bottom edge **104**A of the bottom rail **104**. To prevent such a misalignment, the corner gusset **148** can be constructed so that a lower portion **148**L that extends below the bottom rail **104** is offset laterally-inward from an upper portion **148**U that is sandwiched between the cross-member ends and the bottom rail **104**. The upper and lower portions **148**U, **148**L can be parallel with each other and offset by an amount equal to a material thickness of the end plates **112**A of the cross-members **112** so that the exposed outer surface

of the lower portion **148**L has a smooth transition to and is flush with the directly-adjacent primary reinforcement member **170**, **170**A as indicated by the double arrow in FIG. **19**.

FIGS. **13** and **14** illustrate a lateral reinforcement member **180** that provides supplemental lateral structural support for the corner gusset **148** in the event of an impact to the rear impact guard of the trailer by extending in a laterally-inboard direction from an interior side of the corner gusset **148** to which it is secured. Although only one corner gusset **148** on one side of the trailer is shown in the drawings, it will be understood that lateral reinforcement members **180** are provided along both of the corner gussets **148**, at opposite ends of the rear bolster **128**. A first or laterally-outboard end **180**A of the lateral reinforcement member **180** is secured to the corner gusset **148**. A mounting hole in the first end **180**A can also be provided for alignment with a mounting hole in a tab or gusset (not shown) extending laterally-inwardly from one of the primary reinforcement members **170**, **170**A so that the lateral reinforcement member **180** can be fastened (e.g., bolted) to the primary reinforcement member. As shown, the first end **180**A can have edges that extend along both the vertically-extending inward-facing surface **1481**. and a horizontally-extending surface of a transverse flange **148**B of the corner gusset **148** (e.g., that forms a short leg of the "L" shaped corner gusset **148**). The first end **180**A of the lateral reinforcement member **180** can be welded to the corner gusset **148** along its edges. The lateral reinforcement member **180** has a leg **182** extending laterally inward from the first end **180**A to a second or laterally-inboard end **180**B of the lateral reinforcement member **180** secured at an inwardly-spaced connection point to the rear bolster **128**. For example, the second end **180**B of the lateral reinforcement member **180** can be secured (e.g., bolted or welded) to an upper return flange **128**A of the rear bolster **128**. The lateral reinforcement member **180** can be constructed of sheet metal that is cut into shape and bent into the form shown. The above-mentioned edges are formed by a sheet thickness of the material forming the lateral reinforcement member **180**. The lateral reinforcement member **180** provides a truss effect that reinforces the corner gusset **148** to inhibit the corner gusset **148** from rolling or folding over during a rear impact. The lateral reinforcement member **180** allows reinforcement of the corner gusset **148** without any direct connection to any of the cross-members **112** in the trailer floor. Thus, the rear frame structure and the floor can be manufactured and assembled as separate sub-assemblies.

FIG. **15** illustrates a lateral reinforcement member **190** that provides supplemental lateral structural support for the corner gusset **148** in the event of an impact to the rear impact guard of the trailer by extending in a laterally-inboard direction from an interior side of the corner gusset **148** to which it is secured. Although only one corner gusset **148** on one side of the trailer is shown in the drawings, it will be understood that lateral reinforcement members **190** are provided along both of the corner gussets **148**, at opposite ends of the rear bolster **128**. A first or laterally-outboard end **190**A of the lateral reinforcement member **190** is secured to the corner gusset **148**. As shown, the first end **190**A can lie on the horizontally-extending surface of the transverse flange **148**B of the corner gusset **148**. The lateral reinforcement member **190** can be welded or bolted to the corner gusset **148** at the first end **190**A. The lateral reinforcement member **190** has a leg **192** extending laterally inward from the first end **190**A to a second or laterally-inboard end **190**B of the lateral reinforcement member **190** secured at an inwardly-spaced connection point to the rear bolster **128**. For example, the second end **190**B of the lateral reinforcement member **190** can be secured (e.g., bolted or welded) to a lower return flange **128**B of the rear bolster **128**. Thus, the lateral reinforcement member **190** extends in a horizontal plane, perpendicular to the vertical rear frame post **108**. The lateral reinforcement member **190** can be constructed of sheet metal or plate or bar stock that is cut to length, and optionally shaped. The lateral reinforcement member **190** provides a truss effect, providing an in-plane tensioning strap, that reinforces the corner gusset **148** to inhibit the corner gusset **148** from rolling or folding over during a rear impact. The lateral reinforcement member **190** allows reinforcement of the corner gusset **148** without any direct connection to any of the cross-members **112** in the trailer floor. Thus, the rear frame structure and the floor can be manufactured and assembled as separate sub-assemblies. In some constructions, the lateral reinforcement member **190** may have one or more connections with the adjacent outboard post **136**, such as the gusset **145** thereof. In some constructions, one or both of the ends **190**A, **190**B of the lateral reinforcement member **190** may have shared connection points (e.g., bolted joints) that provide connections between the outboard post **136** and one or both of the rear bolster **128** and the corner gusset **148**.

FIGS. **16** and **17** illustrate a lateral reinforcement member **200** that provides supplemental lateral structural support for the corner gusset **148** in the event of an impact to the rear impact guard of the trailer by extending in a laterally-inboard direction from an interior side of the corner gusset **148** to which it is secured. Although only one corner gusset **148** on one side of the trailer is shown in the drawings, it will be understood that lateral reinforcement members **200** are provided along both of the corner gussets **148**, at opposite ends of the rear bolster **128**. A first or lower end **200**A of the lateral reinforcement member **200** is secured to the corner gusset **148**. As shown, the first end **200**A can have edges that extend along both the vertically-extending inward-facing surface **148**A and a horizontally-extending surface of the transverse flange **148**B. The first end **200**A of the lateral reinforcement member **200** can be welded to the corner gusset **148** along its edges. A mounting hole in the first end **200**A can also be provided for alignment with a mounting hole in a tab or gusset (not shown) extending laterally-inwardly from one of the primary reinforcement members **170**, **170**A so that the lateral reinforcement member **200** can be fastened (e.g., bolted) to the primary reinforcement member. The lateral reinforcement member **200** has a leg **202** extending along the inward-facing surface **148**A from the first end **200**A to a second or upper end **200**B of the lateral reinforcement member **200** secured (e.g., by welding) at a vertically-higher connection point to the inward-facing surface **148**, and optionally to a distal end of the upper return flange **128**A of the rear bolster **128**. In some constructions, an entire edge **204** of the lateral reinforcement member **200** from the first end **200**A to the second end **200**B can abut the inward facing surface **148**A. of the corner gusset **148**, and one or more welds may secure the lateral reinforcement member **200** to the corner gusset **148** along the edge **204**. The lateral reinforcement member **200** can extend along a majority of a vertical extent of the corner gusset **148**. A portion of the lateral reinforcement member **200** can extend above a bottom edge **104**A of the bottom rail **104**, and a portion of the lateral reinforcement member **200** can extend below the bottom edge **104**A of the bottom rail **104**. The lateral reinforcement member **200** can be constructed of sheet metal that is cut into shape and bent into the form shown. The above-mentioned edges are formed by a sheet thickness of the material forming the lateral reinforcement

member **200**. The lateral reinforcement member **200** serves as a transverse rib that reinforces the corner gusset **148** to inhibit the corner gusset **148** from rolling or folding over during a rear impact. The lateral reinforcement member **200** allows reinforcement of the corner gusset **148** without any direct connection to any of the cross-members **112** in the trailer floor. Thus, the rear frame structure and the floor can be manufactured and assembled as separate sub-assemblies.

FIG. **18** illustrates a lateral reinforcement member **210** that provides supplemental lateral structural support for the corner gusset **148** in the event of an impact to the rear impact guard of the trailer by extending in a laterally-inboard direction from an interior side of the corner gusset **148** to which it is secured. Although only one corner gusset **148** on one side of the trailer is shown in the drawings, it will be understood that lateral reinforcement members **210** are provided along both of the corner gussets **148**, at opposite ends of the rear bolster **128**. The lateral reinforcement member **210** incorporates features of both FIGS. **13-14** and FIGS. **16-17**. A first or lower and laterally-outboard end **210**A of the lateral reinforcement member **210** is secured to the corner gusset **148**. As shown, the first end **210**A can have edges that extend along both the vertically-extending inward-facing surface **148**A and a horizontally-extending surface of the transverse flange **148**B. The first end **210**A of the lateral reinforcement member **210** can be welded to the corner gusset **148** along its edges. A mounting hole in the first end **210**A can also be provided for alignment with a mounting hole in a tab or gusset (not shown) extending laterally-inwardly from one of the primary reinforcement members **170**, **170**A so that the lateral reinforcement member **210** can be fastened (e.g., bolted) to the primary reinforcement member. The lateral reinforcement member **210** has a first leg **212** extending along the inward-facing surface **148**A from the first end **210**A to a second end **210**B of the lateral reinforcement member **210** secured (e.g., by welding) at a vertically-higher connection point to the inward-facing surface **148**, and optionally to a distal end of the upper return flange **128**A of the rear bolster **128** (although not shown). In some constructions, an entire edge **214** of the lateral reinforcement member **210** from the first end **210**A to the second end **210**B can abut the inward facing surface **148**A of the corner gusset **148**, and one or more welds may secure the lateral reinforcement member **210** to the corner gusset **148** along the edge **214**. The lateral reinforcement member **210** further includes a third end spaced laterally inward from the first and second ends **210**A, **210**B by a second leg **216**. The third end **210**C can provide a laterally-inboard connection point at which the lateral reinforcement member **210** is secured (e.g., by welding or a bolt) to an upper return flange **128**A of the rear bolster **128**. The lateral reinforcement member **210** can be constructed of sheet metal that is cut into shape and bent into the form shown. The lateral reinforcement member **210** provides both a rib effect and a truss effect to support the corner gusset **148**.

FIGS. **20-25** illustrate another embodiment of an outboard corner post **236** for a trailer rear impact guard. It will be understood that, while one corner post **236** is illustrated, the features shown and described may be utilized at both lateral sides of the rear impact guard (e.g., where the second corner post is a mirror image of the corner post **236** shown). The outboard corner post **236** is a bolt-on post that utilizes a removable, non-permanent connection at its lower end to the bumper **124**. In other words, the post **236** is not welded or fused to the bumper **124**. Similarly, the upper end of the post **236** utilizes a removable, non-permanent connection to the rear of the trailer frame such that the post **236** is not welded or fused to any portion thereof. One or more inboard posts between the outboard posts **236** may also be provided, each extending from the rear bolster **128** to the bumper **124**. If the inboard post(s) are also provided with non-permanent connections to the trailer frame and the bumper **124**, the bumper can be a serviceable item that is replaceable without replacing any other portion of the rear impact guard. Further, the entire rear impact guard can be manufactured and assembled as a sub-assembly, separate from and attachable to the trailer frame. To the extent necessary, the rear impact guard as a whole can be a serviceable item that is replaceable without the need for any destructive means to separate the posts from the trailer frame. While not required in all constructions, a rear-most panel **240** of the outboard post **236** is provided with one or more (e.g., two) apertures that reduce the overall weight of the post **236**. The illustrated layout of the apertures is only one exemplary embodiment, and the apertures can vary in number and layout. In some constructions, the aperture(s) define a cumulative area that is more than 20 percent, more than 30 percent, or even more than 40 percent of a total area of the panel **240** defined by its total periphery.

Although the bumper **124** can be provided by a hollow tubular member having a uniform cross-section along its axis A as shown, a stem or mounting bracket **246** can be secured to an outer surface of the bumper **124** to provide mounting locations for attaching the lower end of the post **236**. Multiple mounting locations are provided by the mounting bracket **246** (e.g., holes for receiving removable fasteners such as bolts), The mounting bracket **246** can be form-fitting around multiple surfaces of the bumper **124** and constructed to protrude therefrom. For example, the mounting bracket **246** can wrap around both a top side **124**A and a front side **124**B of the bumper **124** as shown in FIG. **24**. The mounting bracket **246** can be welded to the outer surface(s) of the tube forming the bumper **124**, thus forming a bumper assembly or weldment. As noted in FIGS. **22-24**, the mounting bracket **246** can include multiple non-planar panels **250**, **252**, **254** that respectively align with the multiple panels **240**, **242**, **244** of the outboard post **236** to lie surface-on-surface therewith. As shown, three panels are provided, but more or fewer panels may be provided in other constructions. Each of the panels **250**, **252**, **254** has at least one mounting hole **260**, and the laterally-outboard panel **252** includes two mounting holes **260**, arranged side-by-side. The mounting holes **260** of the mounting bracket **246** correspond to an identical arrangement of mounting holes **262** on the panels **240**, **242**, **244** of the post **236**. In some constructions, not all of the panels **240**, **242**, **244**, **250**, **252**, **254** include mounting holes. For example, in some constructions, the mounting holes **260**, **262** in the forward-most panels **244**, **254** are omitted.

Although the rear-most panels **240**, **250** of the post **236** and the mounting bracket **246** extend vertically to define a vertical surface-to-surface interface, there is at least one non-vertical surface-to-surface interface defined between the post **236** and the mounting bracket **246**, In an upward direction from the bumper **124**, the laterally-outboard panels **242**, **252** extend further laterally outboard to form an acute angle with the bumper axis A. As such, the panels **242**, **252** are oblique to the axis A. As shown in FIG. **23**, the mounting holes **260** in the laterally-outboard panel **252** define respective parallel axes B (extending centrally through the holes **260**, perpendicular to the panel **252**), both of which are oblique to the horizontal bumper axis A. As shown in FIG. **24**, the mounting hole **260** in the forward-most panel **254** defines an axis C (extending centrally through the hole **260**, perpendicular to the panel **254**), which is oblique to the

horizontal bumper axis A. When the post **236** is assembled with the mounting bracket **246**, the mounting holes **262** of the post **236** align with the mounting holes **260** and assume the same orientations as described above. The respective axes B, C define the axes along which respective bolts (not shown) are inserted to join the post **236** to the mounting bracket **246**.

Another feature of the post **236** of FIGS. **20-25** is a supplementary or back-up plate **270** at the top end of the post **236**. The back-up plate **270** lies directly alongside the rearmost panel **240** in the upper area defining the mounting location or flange **247**. The flange **247** and the back-up plate **270** jointly form a pair of mounting holes **249** for connection to the trailer frame. The back-up plate **270** reduces the tear-out stress around the bolts during an impact, inhibiting the bolts from tearing out of the flange **247**. The added strength is provided across the flange **247** without incurring a weight penalty that would accompany the use of a thicker sheet for the entire panel **240**.

It should be noted that the posts **136**, **236** disclosed herein can be constructed with one or more additional panels beyond the three-panel construction shown. For example, the disclosed corner posts **136**, **236** or modified variants thereof can be provided with an extended wrap-around flange forming a fourth panel that extends alongside the forward-most panel **144**, **244**, at an angle therewith. The fourth panel can extend in an at least partially rearward direction, and one example of such a fourth panel **161** is shown in dashed lines in FIG. **4**. Likewise is the case for the mounting bracket **246**, which can feature another panel alongside the forward-most panel **254**. The fourth panel can extend

The embodiments described above and illustrated in the figures are presented by way of example only and are not intended as a limitation upon the concepts and principles of the present invention. As such, it will be appreciated by one having ordinary skill in the art that various changes in the elements and their configuration and arrangement are possible without departing from the spirit and scope of the present invention as set forth in the appended claims. For example, one having ordinary skill in the art will appreciate that specific features of the numerous embodiments disclosed may be mixed and matched in other ways where not specifically inhibited, even though specific illustration of such embodiments may not be exhaustively covered herein.

What is claimed is:

1. A rear impact guard for attachment to a rear frame portion of a trailer, the rear impact guard comprising:

a bumper extending along an axis defining a first direction to be oriented transversely to span laterally at a distance below the rear frame portion;

a pair of outboard posts extending from respective opposed distal ends of the bumper in a second direction so that the bumper can be spaced below the rear frame portion by the pair of outboard posts; and

at least one inboard post extending from the bumper at a location between the pair of outboard posts,

wherein each of the pair of outboard posts has a lower end that overlaps with a respective mounting bracket that protrudes upwardly from the bumper such that mounting holes of the outboard posts align with mounting holes of the mounting brackets, and

wherein each mounting bracket has a laterally-outboard panel that extends obliquely from the bumper in a direction with a laterally-outward component.

2. The rear impact guard of claim **1**, wherein each of the mounting brackets is welded to the bumper.

3. The rear impact guard of claim **1**, wherein each mounting bracket includes a forward panel, a rearward panel, and a laterally-outward panel connecting the forward and rearward panels, and each mounting bracket is open in a laterally-inward direction.

4. The rear impact guard of claim **1**, wherein each mounting bracket includes a forward panel, a rearward panel, and a laterally-outward panel connecting the forward and rearward panels, and wherein each of the forward, rearward, and laterally-outward panels includes at least one mounting hole.

5. The rear impact guard of claim **1**, wherein the bumper has a hollow rectangular construction in a cross-section perpendicular to the axis.

6. The rear impact guard of claim **1**, wherein each of the mounting brackets wraps around both a front side and a top side of the bumper.

7. The rear impact guard of claim **1**, wherein each of the pair of outboard posts includes a plurality of panels all having first ends extending from the mounting bracket on the bumper, and wherein a top gusset extends parallel to the axis between the plurality of panels at opposite second ends thereof to provide an upper surface for abutment with the rear frame portion.

8. The rear impact guard of claim **1**, wherein an upper portion of each of the outboard posts includes apertures for establishing non-permanent, removable connections to the rear frame portion.

9. The rear impact guard of claim **8**, wherein the apertures of the upper portions of each of the outboard posts include at least one aperture oriented to receive a fastener along a first perpendicular direction with respect to the axis defined by the bumper, and at least one aperture oriented to receive a fastener along a second perpendicular direction with respect to the axis defined by the bumper.

10. The rear impact guard of claim **8**, wherein the apertures of the upper portions of each of the outboard posts include two apertures oriented to receive respective fasteners parallel to a first perpendicular direction with respect to the axis defined by the bumper, and two apertures oriented to receive respective fasteners parallel to a second perpendicular direction with respect to the axis defined by the bumper.

11. A trailer comprising:

a front end provided for attachment to a truck;

a rear end spaced in a longitudinal direction from the front end to define a cargo area between the front and rear ends:

a frame including

a pair of laterally spaced vertical corner posts at the rear end,

a rear bolster extending transversely to the longitudinal direction below a bottom rear edge of the cargo area, between the pair of vertical corner posts, and

a pair of corner gussets extending forwardly from respective bottom portions of the pair of vertical corner posts; and

a rear impact guard including

a bumper positioned at the rear end of the trailer and spaced below the rear bolster,

a pair of outboard posts, each having a lower end secured to a distal end of the bumper and an upper end secured to a laterally outboard portion of the frame, and

at least one inboard post extending between the bumper and the rear bolster at a location between the pair of outboard posts,

wherein each of the pair of outboard posts includes a plurality of panels extending between the upper and lower ends, and a top gusset extending between and interconnecting the plurality of panels, the top gusset defining a top surface supporting a bottom of each of: the rear bolster, the respective one of the pair of vertical corner posts, and the respective one of the pair of corner gussets.

12. The trailer of claim **11**, wherein the plurality of panels of each of the pair of outboard posts include three panels interconnected by the top gusset.

13. The trailer of claim **11**, wherein each of the pair of outboard posts is secured to the frame of the trailer solely with non-permanent, removable connections.

14. The trailer of claim **11**, wherein one of the plurality of panels of each of the pair of outboard posts is a rear panel provided with at least one aperture oriented to receive a fastener parallel to the longitudinal direction for securing to the rear bolster, and wherein the top gusset of each of the pair of outboard posts is provided with at least one aperture oriented to receive a fastener in a vertical direction parallel to the pair of vertical corner posts for securing to the respective one of the pair of corner gussets.

15. The trailer of claim **11**, wherein the pair of corner gussets are fortified with respective lateral reinforcement members, each of which is secured to an interior side of a corresponding one of the pair of corner gussets and each of which extends laterally-inboard from the corresponding corner gusset.

16. The trailer of claim **15**, wherein the top gusset of each of the pair of outboard posts extends to span underneath a position at which the respective lateral reinforcement member is joined with the respective corner gusset.

17. The trailer of claim **15**, wherein each of the lateral reinforcement members has a leg extending laterally inward from the respective corner gusset to an inwardly-spaced connection point at which the lateral reinforcement member is secured to the rear bolster, and wherein each of the lateral reinforcement members has an additional leg elongated to extend along an inward-facing surface of the respective corner gusset.

18. The trailer of claim **15**, wherein the lateral reinforcement members are secured, respectively, to inward-facing surfaces of the pair of corner gussets by welding.

19. The trailer of claim **18**, wherein each of the lateral reinforcement members has an edge abutting and extending along the inward-facing surface of the respective corner gusset.

20. The trailer of claim **18**, wherein each of the lateral reinforcement members has a leg extending laterally inward from the inward-facing surface of the respective corner gusset to an inwardly-spaced connection point at which the lateral reinforcement member is secured to the rear bolster.

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